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The Zurich Meeting of the International Astronomical Union

By OTTO STRUVE

Upon our arrival at the Zürich railroad station we were met by a charming young lady and an efficient assistant of the observatory, standing on the platform under a large sign reading IAU. From this moment on, and until the end of the convention on August 18, we were being looked after by the members of the local committee on arrangements under Professor and Mrs. Waldmeier of Zürich. A small booklet issued to us at the railroad station contained a map of the city and pertinent information about the events of the week, but it is doubtful whether many astronomers had enough energy left to avail themselves of the many attractions of a city whose prosperity and general look of "normalcy" reminded us of the years before 1914. One who with his usual thoroughness worked his way through all the details of this little guide book was Professor M. Minnaert of Utrecht, Holland. Stuck away in one of the inside pages he found an item—especially appropriate for an astronomical convention—the horoscope of the week: "The Sign of Leo—quiet week—nothing of importance."

Nothing of importance, indeed, when more than 400 astronomers from some 30 countries had come together for the first time since the Stockholm assembly of the Union in 1938, when Sir Arthur Eddington, as the newly-elected president, had made his memorable speech of acceptance and had pronounced these strangely prophetic words:

> "We cannot foresee what may happen before we meet again in Zürich. On the astronomical side we can make some guess. The 200-inch reflector will be completed or approaching completion. The marvellous advance in the photography of the corona and prominences, which has been so memorable a feature of this meeting, will bear fruit in advancing knowledge. And our numerous commissions will patiently extend their researches. But on the international side no one dares prophesy. But, if in international politics the sky seems heavy with clouds, such a meeting as this at Stockholm is as when the sun comes forth from behind the clouds. Here we have formed and renewed bands of friendship which will resist the forces of disruption."

Sir Arthur Eddington had died during the war, and had been replaced as president by the Astronomer Royal, Sir Harold Spencer Jones, whose term of office expired at the end of the Zürich conference. Dr. J. H. Oort again functioned as General Secretary, an office

which he has held since the retirement of his predecessor, Professor F. J. M. Stratton of Cambridge, England. Dr. Oort had announced his desire to retire as General Secretary at the end of the present meeting. He was given a tremendous ovation during the last session, on August 18, with the entire membership standing in his honor. His quiet, efficient, and impartial conduct of the work of the Union during the difficult years of the war, and especially during the past three years of reconstruction, has not only won for him the admiration, respect, and affection of the vast majority of astronomers of all nations, but has created a lasting monument in the history of international science.

The Executive Council of the Union, as constituted at the organizational conference at Copenhagen, in March, 1946,* consisted, in addition to Sir Harold Spencer Jones and Dr. J. H. Oort, of the following vice-presidents: Professor G. Abetti of Arcetri, Italy; Dr. W. S. Adams of Mt. Wilson, U.S.A.; Professor W. Brunner of Zürich, Switzerland (who was later replaced by Professor G. Tiercy of Geneva, Switzerland); Professor A. Danjon of Paris, France; and Dr. A. A. Mikhailov of Moscow, U.S.S.R. All the vice-presidents, with the exception of Dr. Adams, were present at the meeting. The latter was replaced by proxy, for the duration of the Zürich meeting, by Professor J. Stebbins of Madison, Wisconsin.

The structure of the Union is the following. Adherence is by countries, usually through a national academy or a national research council. Nearly all countries in which astronomical research is being carried on are members of the Union, except Germany, which never applied for admission. Japan was a member long before the last war, and, not having resigned or been removed, it is still a member-nation. One or two countries are strangely missing among the members, for example New Zealand. The Philippines, now independent, have not applied for admission, but, at the suggestion of the present writer who was appointed chairman of the nominating committee, Philippine astronomers will be accorded the same status as astronomers from the United States until 1951, when it is hoped that the Philippines may have joined the Union as an independent nation. Each nation pays dues on a scale adopted at the meeting, which essentially reflects the development of astronomy in that country, and it votes on organizational matters with a number of votes roughly proportional to the amount of its dues. It is of interest that not once during the present meeting was there a roll-call by nations, except for the formation of the finance committee. All organizational questions were decided without opposition. Most of the organizational work of the Union is conducted by the President and the General Secretary, with advice from the Executive Council. The scientific work, however, is almost entirely in the hands of the special commissions, of which there are now 40, and of their numerous subcommissions. At each general meeting a nomin-

*Popular Astronomy, **54**, 327, 1946.

ating committee is appointed by the Executive Council, and this committee prepares the lists of members of the commissions and subcommissions. It also makes suggestions regarding the appointments to the important offices of commission and subcommission chairmen. The Executive Council scrutinizes the lists of members, and especially that of chairmen, and proposes for election at the last session the complete membership of all the commissions. Only astronomers from member-nations are eligible, but each commission has the right, at the initiative of its chairman and with the final sanction of the Executive Council, to co-opt additional members, irrespective of the adhering nations. German astronomers are again eligible for co-option, as they were before 1939. So are Japanese astronomers, who were not included in the lists drawn up by the nominating committee because the Executive Council ruled that there was not now available enough information regarding the qualifications of the Japanese astronomers. It is to be expected that their very obvious efforts to cooperate with the Union by having sent to the various commissions reports concerning their work will be rewarded by the machinery of co-option.

In addition to membership through the commissions, the various national organizations participating in the Union may recommend for membership at large those of their astronomers who deserve to be inincluded, and are not already members (elected or co-opted) of the commissions. The Executive Council passes upon these recommendations. The U. S. Section of the Union had decided to recommend membership status for the duration of the Zürich meeting to all professional astronomers who wished to attend this meeting, but of course this type of membership automatically expired at the close of the conferences. Approximately fifty Americans attended the meeting, including many of our more distinguished astronomers.

Membership in the Union represents a certain distinction, since it cannot be secured through individual initiative. Yet, the Union has never accurately defined the qualifications of its members. At the Zürich meeting the nominating committee took the view that participation in active research within the scope of a given commission, and as indicated by published results, represented a necessary (but not always a sufficient) qualification. The U. S. delegation (the voting delegates were Hubble, Jeffers, Stebbins, Shapley, Brouwer, and the present writer) was guided by a list of recommendations prepared in advance by a special committee appointed by the American Astronomical Society. This list was prepared with the intention of reducing (rather than increasing) the already heavy preponderance of American astronomers in the Union. It was adopted almost in its entirety. With a few minor omissions and additions, the final representation of Americans in the Union is that recommended by the A.A.S. committee. Some of the foreign commission chairmen added a few American names to their lists, but most of them are duplications. The American delegation de-

cided not to make a distinction, in its recommendations, between U.S.A. citizens and those of its permanent residents who have not been able to acquire citizenship. But under the new constitution of the U.S.A. Section its chairman must be a citizen of the U. S. and presumably all voting delegates will always be citizens.

The question of membership is not an easy one, and it is probable that a few persons have been unjustly slighted. I believe that anyone who has reason to feel that he should be included should communicate with the appropriate commission chairman or with some American member of the Union. But this should only be done if the case is really serious. We already have an excessive amount of representation in the Union, and I wish to assure everyone, as strongly as I can, that omissions, if they have occurred, were not intentional. After all, membership in a commission of the Union neither adds to nor subtracts from one's accomplishments. As far as participation at future meetings is concerned our democratic procedure of the past may only have to be modified if there should be danger that Americans would so completely outnumber others that some sort of self-imposed restrictions will be necessary. I can visualize that such restrictions may perhaps have to be adopted in the event of a meeting in the U.S.A. Otherwise, I am sure that all working astronomers will again be accorded membership. But, of course, a meeting of the Union is serious business—strenuous for many of us. It should not be regarded as an occasion for some free entertainment; and the enjoyment of such magnificent scenery as that of Switzerland should really come as a reward for some substantial scientific or organizational contribution to the meeting, and should never be the principal object of the trip.

The new list of members, which has as yet no co-options, contains nearly 1200 names, of which many are duplications. On the average, each name occurs about twice. The U.S.A. has members in all commissions. The distribution among the various nations of the important offices of commission chairmen, vice-chairmen, secretaries, and directors of bureaus is as follows:

United States	25	U.S.S.R.	3
France	13	Denmark	3
Canada (5)	13	Belgium	2
Great Britain (4)		Switzerland	1
South Africa (3)		Poland	1
Australia (1)		Italy	1
Holland	4		

The American office-holders are:

Commission	*Subcommission*	*Name*	*Office*
4 (Ephemerides)	(Astr. Constants)	Brouwer	Chairman
7 (Cel. Mechanics)	.....	Clemence	Chairman
8 (Merid. Astr.)	.....	Watts	Chairman
8 (Merid. Astr.)	(9th mag. stars)	Brouwer	Chairman
13 (Solar Ecl.)	.....	Menzel	Chairman
14 (Wave-Lengths)	.....	Meggers	Chairman

14 (Wave-Lengths)	.....	G. R. Harrison	Secretary
14 (Wave-Lengths)	(Intensities)	R. B. King	Chairman
19 (Var. of Lat.)	.....	Sollenberger	Chairman
20 (Minor Planets)	.....	Leuschner	Hon. Chairman
20 (Minor Planets)	.....	Brouwer	Chairman
22 (Meteors)	.....	Whipple	Chairman
26 (Double Stars)	.....	Aitken	Hon. Chairman
28 (Extra-gal. Neb.)	.....	Hubble	Chairman
28 (Extra-gal. Neb.)	.....	N. U. Mayall	Secretary
29 (Stellar Spectra)	.....	Struve	Secretary
29 (Stellar Spectra)	(Variables)	P. W. Merrill	Chairman
30 (Radial Velocities)	(Fund. Vel.)	Sanford	Chairman
30 (Radial Velocities)	(Sp. Bin.)	J. H. Moore	Chairman
34 (Interst. Matter)	.....	Struve	Chairman
35 (Stellar Constit.)	.....	Chandrasekhar	Chairman
37 (Clusters)	.....	Baade	Chairman
39 (Int. Observ.)	.....	Shapley	Chairman
41 (History)	.....	Neugebauer	Chairman
42 (Photometric Binaries)	.....	Kopal	Chairman

The new members of the Executive Council are not proposed by the nominating committee, but are recommended by the Executive Council itself, and are then usually elected by acclamation at the last general session. The new president is Professor Bertil Lindblad, Director of the Stockholm Observatory at Saltsjobaden, Sweden, and the new general secretary is Dr. B. Strömgren, Director of the Copenhagen Observatory, Denmark. The new vice-presidents are Academician V. A. Ambarzumian of the Soviet Union, to replace Prof. A. A. Mikhailov, and the present writer, to replace Dr. Adams.

I confess that the organization of the IAU has always seemed awkward to me, and in some respects it is certainly not democratic. For example, I wonder whether the eminently fair manner in which the former Executive Council chose its successors is a sufficient guarantee against future misuse of power. And are we entirely certain that even now our satisfaction with the choice of the new president and general secretary is wholly free of what might be called the nordic point of view? It is very difficult to offer an alternative plan. Yet, most of us in America would probably favor a procedure which would give some sort of assurance against unreasonable appointments. I have also been critical of the manner in which the commissions are set up, and I believe, even more so than previously, that the work of the Union would go more smoothly if the majority were members at large, and if only persons actively concerned with the work of a commission should become its members. At present, it is almost necessary to use the 40 commissions as pigeonholes for the assignment of names. The only justification that I can see is that it might stimulate an astronomer to do some work in the field covered by the commission to which he has been assigned.

In accordance with a new ruling there are eight categories of membership by countries, numbered 1 to 8. Each adhering country pays a number of units of subscription equal to the number of its category of membership. Each adhering country specifies in which category it

proposes to be classified but the Executive Council decides whether the proposed classification is adequate. In each country the organization adhering to the Union is responsible for the payment. At Zürich the unit of payment was set at 500 gold francs, or $163.30. Since the U.S.A. belongs to the highest category, its annual contribution, for the next three years, should be $8 \times \$163.30 = \$1{,}306.40$. On scientific matters each delegate has one vote, on questions of administrative character each country has one vote, while on financial questions each country has a number of votes exceeding by 1 the number of its category. For the U.S.A. this is $8 + 1 = 9$ votes.

Most of the work during the present meeting was done in the commissions. Since the sessions overlapped, no single person could attend all the meetings. It is my impression that there was a wide variety of procedure and accomplishment. Some of the commissions held only one conference, while others had many. Some devoted themselves to questions of organization, nomenclature, etc., while others favored formal or informal exchange of scientific information.

Among the commission meetings some of the most interesting which I attended were Hubble's commission on extragalactic nebulae in which he outlined his plan for the great Atlas of nebular photographs from the Mt. Wilson Observatory, and followed with a general discussion of the problem of the masses of the galaxies; Meggers' spectacular presentation to the international bureau of weights and measures of one of the first mercury lamps made with an artificially pure isotope of the metal. The commission on stellar constitution presided over by Milne (in the absence of Russell) at which an interesting difference in point of view developed between the group of young Cambridge theoretical astrophysicists and Dr. Ledoux, who is one of the most capable representatives of what might be described as the Chandrasekhar school of theoretical astrophysics. What a pity that Chandrasekhar was not there! In the commission on radial velocities, presided over by J. A. Pearce, Dr. R. E. Wilson of Mt. Wilson described his new catalogue of stellar radial velocities which is to take the place of J. H. Moore's catalogue in the *Publications of the Lick Observatory* (which was also sponsored by the IAU, in 1932). It was a relief that no financial subsidy was requested for this important compilation. And several sessions of the subcommission on the light of the night sky, presided over by Dufay, at which important papers were presented by Swings, Whipple, Kaplan, Tcheng Mao Lin, Barbier, and others. Dr. Hubble gave an invited lecture on the 200-inch telescope describing his plan for research with this new instrument. There was an excellent exhibition of instruments, photographs, books, and various records. Large-scale photographs of the 200-inch occupied a special place of honor. Very impressive was also the exhibit of the results of 100 years of sunspot observations at Zürich (by Wolf, Wolfer, Brunner, and now by Waldmeier).

One special session was set aside for a symposium in Commission 36 (Spectrophotometry), with M. Minnaert presiding, on problems of infrared spectroscopy. The present writer read a paper by Dr. G. P. Kuiper outling his work with the lead-sulphide photo-conductive cell of Professor Cashman. The most spectacular portion of this paper dealt with Kuiper's discovery of the steep absorption in the infrared which is produced by ice, in the rings of Saturn and the inner satellites of Saturn. His conclusion that the spectrum resembles that of a thin sheet of ice, equivalent to about 1 mm of water-cell absorption, and that he envisages a thin layer of hoar-frost on top of a very cold surface—perhaps of solid ice—was new to most of the European astronomers. Dr. L. Goldberg, Director of the University of Michigan Observatory, and Dr. M. Migeotte of Liège (and recently of Ohio State University) described their high-dispersion work on the sun, the former with a PbS cell, the latter with a specially constructed bolometer. The discovery of methane and ammonia absorption in the earth's atmosphere, was supplemented by Goldberg's identification of numerous lines and bands in the sun's atmosphere.

In the Commission on stellar spectra Dr. P. Swings presided over a symposium on the spectral classification and its anomalies. He has prepared the following account.

> Seven papers were presented by astronomers from France (Dr. D. Barbier), Canada (Dr. C. S. Beals), Sweden (Dr. J. Ramberg), Belgium (Dr. P. Swings), U.S.S.R. (Dr. V. Ambarzumian), and U.S.A. (Drs. J. J. Nassau and A. N. Vyssotsky). In addition Mrs. Margaret Mayall and Miss Walther commented on the programs of spectral classification at present under way at Harvard College Observatory.
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> Dr. J. J. Nassau's paper dealt mainly with the classification of spectra secured with a 4° objective prism attached to the 24-36 inch Schmidt-type telescope of the Warner and Swasey Observatory; the dispersion at Hγ is 283A/mm. Spectra obtained with a 2° objective prism were also dealt with briefly. First Dr. Nassau considered the long-exposure spectra intended for statistical studies; next he discussed the short-exposure spectra for detailed study of individual stars; finally he considered the infrared spectra for classification of low temperature stars. Thanks to sets of excellent enlargements the criteria for classification in spectral type and luminosity appeared very clearly. The infrared spectra are especially interesting, reaching M stars as faint as 14.4 infrared magnitude. The S stars are identified by a band at λ7950 which is probably due to LaO, according to P. C. Keenan.
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> Next Dr. D. Barbier reported on some work carried out by Dr. D. Chalonge and himself in Paris, on the classification of early-type stars according to the magnitude and position of the Balmer discontinuity. These two factors depend on the spectral type and absolute magnitude, hence may be used for their determination. The number of stars already examined is rather small, hence the results are only preliminary. The method appears promising, the spectral types and absolute magnitudes obtained from the Balmer discontinuity showing a good correlation with the results of other methods.
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> Dr. J. Ramberg discussed the anomalies observed at the Stockholm Observatory, in the spectrophotometric criteria of stellar luminosity in the spectral sequence of the Hyades. On the basis of various criteria, he found that the members of the Hyades belonging to the main series are systematically fainter than random stars of corresponding spectral types.

The departure in magnitude is largest early in the spectral sequence and decreases with advancing spectral type, disappearing in late K and M dwarfs. This paper gave rise to an interesting discussion by Dr. R. E. Wilson of the Mt. Wilson Observatory who pointed out that the discrepancies indicated by Dr. Ramberg disappear if account is taken of recent work on the parallaxes and on the photoelectric magnitudes of the Hyades stars.

Dr. A. N. Vyssotsky called attention to peculiarities frequently encountered in spectra of short dispersion, such as those obtained at the McCormick Observatory (dispersion, about 300A/mm at Hγ). A list was given of these peculiarities, involving the G-band and Hγ in certain G stars; the "pseudo G-band" near λ4300 in A stars; the sharp H and CaII-lines in certain F stars; the strong narrow line near λ4175 in certain A and F stars; the depression centered near λ4450 in K stars; the behavior of CN in certain K giants; the "Lindblad depression" between λ4227 and λ4310 in all M dwarfs. These peculiarities gave rise to a lively discussion, suggestions being made by Drs. B. Lindblad, L. Gratton, and P. Swings.

Dr. C. S. Beals (Ottawa, Canada) then discussed the place of the Wolf-Rayet stars in the stellar sequence. Dr. Beals' work on these objects, at the Dominion Astrophysical Observatory in Victoria, was reviewed, the emphasis being on our lack of theoretical understanding of the phenomena at play in the atmosphere of a Wolf-Rayet star. It is possible that a clear understanding of the physical relations between the Wolf-Rayet stars and the rest of the sequence will only come about as a result of theoretical studies of the origin of Wolf-Rayet emission.

Dr. P. Swings (Liège, Belgium) reviewed the anomalies present in the Wolf-Rayet, O- and P Cygni-stars. A study of such anomalies will help in realizing the full meaning of normal intensities, hence of the normal classification. In peculiar stars, anomalous intensities are found for individual lines within one atom and for lines of different atoms. Some of these peculiarities may be understood as a result of the geometrical and physical dilution of the exciting radiation; of fluorescence effects (which, themselves, depend on dynamical factors such as rotation or ejection affecting the wave-length coincidences); of abnormal populations due to absorption of radiations such as L^{α} beyond the ionization limits; of anomalous distributions among the various stages of ionization due to the fact that the underlying radiation differs greatly from black-body radiation; of stratification effects. Other peculiarities are at present not yet clearly understood. But the main result is that great caution should be exercised in trying to deduce abundances from line intensities in anomalous stars. Dr. Swings also made suggestions for a re-examination of the criteria of classification of the Wolf-Rayet stars, especially those which are nuclei of planetary nebulae. Some of these nuclei show carbon and nitrogen lines of similar intensities.

This report was commented upon by Dr. Zanstra who emphasized the limitations in the temperature determinations of objects of the Wolf-Rayet type, and by Dr. Ambarzumian who mentioned how the theory of extended atmospheres leads to departures from a black-body curve.

When I started organizing this symposium, several months ago, I wrote to the Astronomical Council of the Academy of Sciences of the Soviet Union asking them to designate a Russian astronomer to take part in the symposium. I never received a reply, but I was gratified when after the arrival of the Soviet delegation in Zürich (they were, as usual, several days late; astronomers are beginning to take bets on the day they will arrive at these international gatherings!) the head of the Russion group, Professor A. A. Mikhailov, informed me that Academician V. A. Ambarzumian would take part in the symposium and would speak on a subject of his own choice.

Ambarzumian, who is an honorary member of the American Astronomical Society, is one of the greatest living astrophysicists. His work has an extraordinary power of physical insight and has exerted a strong influence upon other workers.

At the symposium Ambarzumian spoke on the patchiness of the interstellar absorbing layer. He described his own work, and that of his associates, which has led to the determination of the optical thickness of an average cloud of absorbing material, $\epsilon_0 = 0.25$ mag. But the most exciting statement he made was one regarding the application to this problem of the principle of invariance which he had previously derived for the theory of diffuse reflection. This principle has a remarkable power; its significance was at once recognized by Chandrasekhar and extended by him to many practical applications. Ambarzumian has now considered the fluctuations in the total brightness contained within an area of one square degree. These fluctuations are caused very largely by the intervention of absorbing clouds. In this case the principle of invariance requires that the distribution function should remain the same when the observer is displaced a certain distance Δr in the line of sight. Thus, an equation is formed which determines the transparency of a cloud, $q = 10^{-0.4\epsilon_0}$, from the observed mean square departures of the surface brightness of the Milky Way:

$$\frac{1-q}{1+q} = \frac{\overline{(I-\bar{I})^2}}{\bar{I}^2}$$

The significance of Ambarzumian's communication more than made up for the fact that in a truly Russian "nichevo," or "never mind" fashion he had spoken on a subject that had no obvious relation to the work of the Commission on stellar spectra, but most definitely belonged within the province of Commission 34, on Interstellar Matter. Fortunately, Professor Stebbins, chairman of No. 34, was not present; if he had, he might have felt like wringing my neck. But then, I had an advantage over him. I speak Russian, and he does not!

The principal scientific event of the meeting was a symposium for all members of the Union, on the abundances of the chemical elements in the universe. The individual papers and the lively discussion following this session, will be published in the next volume of the IAU *Transactions*. A summary written for another purpose is given herewith. Unfortunately, the symposium came on the next to the last afternoon, just preceding the official banquet. The large auditorium of the Eidgenossische Technische Hochschule was crammed full to capacity when the symposium started, but as the afternoon wore on the audience became smaller and smaller. The chairman remarked that we had here an interesting case of the transformation of the original composition of the audience from one of uniform distribution of astronomical interests

to one of high concentration of purely astrophysical interest. The unwary observer might conclude that a real "nuclear reaction" was involved, when in reality all that had happened was the "escape" of what he politely refused to describe as "the lighter elements" through the doors. Thus, among the stars differences in composition may or may not be caused by nuclear processes.

NOTES ON THE SYMPOSIUM ON THE CHEMICAL ABUNDANCES IN THE UNIVERSE

It has been known for many years that the stars and nebulae contain the same chemical elements that are found on the earth, beginning with the lightest of them all—the gas hydrogen—and ending with the many metals, such as iron. Even uranium, the heaviest of the elements found naturally in the rocks of Earth's crust, is undoubtedly present in the sun and stars. Our failure to observe in cosmical spectra the characteristic absorptions and emissions of a few of the elements known to us in the "periodic table" has been fully explained by the practical limitations of our instruments and by the opacity of the Earth's atmosphere to far ultraviolet radiations and to certain intervals of red and infrared radiations.

The purpose of the Zürich symposium was to elucidate, if possible, how much of each element can be found in the sun, in different stars, and in nebulae. This is a particularly timely problem, because astronomers had already agreed that in the deep interiors of the stars, where the temperatures may be as high as 20 million degrees, thermo-nuclear reactions are constantly at work—on a scale far surpassing all artificial reactions known to man—converting hydrogen into helium. In an interval of time of the order of 3×10^9 years a considerable fraction of the stars would have lost most of their hydrogen, having "burned it up" in order to radiate heat and light. The gas helium would then appear as the "ashes" of this stupendous nuclear transformation furnace, and the older stars would be expected to be rich in helium and poor in hydrogen.

The astronomers came to Zürich to answer specifically the following questions:

(1) Just exactly what are the relative abundances of the elements in the sun and stars?

(2) Do these abundances differ from those known on the earth?

(3) Are there any "unusual" stars or nebulae with anomalously large or small abundances of certain chemical elements?

(4) Do such cases give any reliable evidence of the nuclear conversion of hydrogen into helium, or are the observations better explained with the help of other physical processes known to exist in the universe, such as stratification of elements by weight or as radiation pressure?

Professor M. Minnaert, Director of the Astronomical Observatory at the University of Utrecht, Holland, reported on his latest findings concerning the composition of the sun. He has used for this purpose measurements of the absorbing properties of different kinds of atoms and has greatly perfected the theory by extending it to encompass the large number of faint Fraunhofer lines in the spectrum of the sun.

Dr. J. Hunaerts, of the Royal Observatory at Uccle (near Brussels), Belgium, extended Dr. Minnaert's report by showing how many molecules of different types there are within a column of 1 square centimeter cross-section of the sun's atmosphere. From the numbers of molecules of CN (cyanogen), CH, OH, etc., he next computed with the help of an elaborate theory of dissociation of molecules the relative numbers of the individual component atom, H, O, C, N, etc.

Both speakers stressed the fact that while errors of the order of a factor of 2 were still present in some of the determinations, all data indicate an amazing similarity of the abundances of the *heavy* elements—heavier than the gas neon—with the chemical composition of the crust of

the earth and with that of the meteorites. The *lighter* elements, including the gases hydrogen, helium, oxygen, etc., have been lost by the earth and also by the meteorites as a result of the gradual escape of these atoms from the relatively weak field of gravitational attraction of the small bodies in the solar system. Unquestionably, the composition of the sun is much more representative than that of the planets and meteorites!

Dr. A. Unsöld, Professor of Theoretical Astrophysics and Dean of the Faculty of the University of Kiel, Germany, spoke on the abundances of the chemical elements in stars. He finds that all those stars which are regarded as forming the "main sequence" of the famous "Russell diagram" have identically the same composition as the sun, again with an uncertainty corresponding to a factor of 2 or 3. Hydrogen is by far the most abundant element. For every atom of *any* metal there are about 6 atoms of carbon, nitrogen, and oxygen; 500 atoms of helium, and 5000 of hydrogen. It is quite evident that these stars have not converted appreciably the original hydrogen into helium—at least not that which is contained in their outermost layers. What we do not yet know is whether the composition of the deep stellar interiors resembles that of their atmospheres.

It is with this problem that Dr. F. Hoyle, Lecturer in Astrophysics at the University of Cambridge, England, concerned himself. His conclusion is that violent convective currents within the stars serve to keep them constantly stirred, so that presumably the composition of the outer layers, which we observe, is the same as that of the interiors, where the nuclear processes take place.

More remarkable even than the uniformity in composition of the "normal" stars is Professor Bengt Strömgren's conclusion that the enormously dilute material of interstellar space also resembles in composition the sun and the stars. He is the director of the University of Copenhagen Observatory and has made an extensive study of the physical conditions of the interstellar gas. One million cubic inches of this gas contain about ten million atoms of hydrogen, 60 atoms of sodium, 100 atoms of calcium, four of potassium, two of titanium. We do not yet know the abundance of helium, but it may be about a million, and of course, all the other elements are also represented with their usual abundances, although they cannot be observed.

It is, indeed, one of the deepest mysteries of the universe that the interstellar matter should have the same composition as the normal stars. It lends support to the theories of Professors L. Spitzer, Jr., of Princeton, and F. Whipple, of Harvard, that the stars have been formed out of the interstellar medium, and Dr. Hoyle spoke at the symposium in support of these ideas.

The uniformity of composition of many astronomical objects was further emphasized by Professor Donald H. Menzel, Associate Director of the Harvard Observatory. His earlier investigations had overestimated the abundance of hydrogen in the planetary nebulae, but recent photographic studies by Dr. W. Baade at Mount Wilson had prompted him to develop a new theory of these nebulae based upon the assumption that their structure is essentially filamentary in character. This results in a much greater value for the density of the nebulae and a smaller abundance of hydrogen—99 per cent of all the atoms—and agrees perfectly with the conclusions of the preceding speakers.

Presumably all of these objects are in their original state, as far as composition is concerned. There is no difficulty about the interstellar gas and the nebulae, because they lack the mechanism which converts hydrogen into helium. Nor is there any difficulty in explaining the original composition of the sun and all *cool* stars of the main sequence. They generate energy at such a slow rate that during their lifetimes of the order of 3×10^9 years, they cannot have converted a large amount of hydrogen. Their spectra would still show the original distribution of the elements. But Dr. Unsöld's result that a hot star

(20,000 degrees absolute at the surface!), Tau Scorpii, also has the same composition, was surprising to many astronomers. Professor Henry Norris Russell, famed astrophysicist of Princeton University who did *not* attend the meeting, had given expression to this surprise in a letter to the chairman of the symposium. Tau Scorpii and other similar stars generate energy at such a prodigious rate that during their "spendthrift" lives of considerably less than 3×10^9 years they may have converted much of their hydrogen into helium. Professor Russell concludes that we observe these stars only when they are quite young and still have the original composition. They must disappear from sight (at least as B-type stars) after they have become old enough to contain little hydrogen.

Dr. Struve, who is Andrew MacLeish Distinguished Service Professor of the University of Chicago, discussed the observational evidence of the existence of stars with abnormal chemical compositions. He concluded that many results previously attributed to abnormal abundances are now attributable to other causes, such as the presence of unusual radiations from the emission of hydrogen atoms, or the absence of certain radiations due to absorptions in deep layers of the stellar atmosphere.

But a few of his own results, as well as those of others, are almost certainly caused by a real scarcity of hydrogen. He compared the spectra of stars in two galactic clusters, the Pleiades and the Hyades, and concluded that the cooler stars have very similar spectra and therefore the same composition. But the hotter stars differ systematically. Previous workers, notably Dr. G. P. Kuiper, director of Yerkes and McDonald Observatories, had suggested that the Hyades are poor in hydrogen content, while the Pleiades are not so poor. Dr. Struve proposes that the difference may be one of age, rather than of original composition. The cooler stars with their more "economical" radiation budgets have not had time to develop noticeable differences, while the more "spendthrift" stars have developed, in the direction of hydrogen-deficiency, to a greater extent in the older cluster (the Hyades).

Professor O. Klein, of the Technological Institute at Stockholm, Sweden, finally, reviewed the theory of the formation of the chemical elements as we now know them with their original abundances. Long before the stars were formed the universe may have been in a state of temperature and density which favored the nuclear reactions required to produce the abundances of the heavier atoms. Then, as the stars came into being, the abundances of the heavy elements became "frozen," since there exist no nuclear processes which can operate with the present properties of stellar material and appreciably change the abundances of the heavy elements. Only the lighter elements continue their metamorphosis.

An interesting communication from an absent astronomer threw additional light upon the topic of atomic abundances. Dr. Andrew McKellar, of the Dominion Astrophysical Observatory, Victoria (B.C.) Canada, sent a report describing his results on the ratio of carbon isotopes C^{12}/C^{13}. These isotopes have precisely the same chemical properties, but they differ slightly in weight. On the earth there are 90 atoms of the lighter variety of carbon for every atom of the heavier variety. But Dr. McKellar has found that in certain stars the ratio is but 3 or 4 to 1. We do not know definitely which physical process is responsible for this difference, but all astronomers agree that it must be significant.

One of the principal activities of the Union is to pass resolutions. This seems peculiar, at first sight, because it smacks of "research by legislation," but a scrutiny of the results shows that, in general, the resolutions serve a useful purpose by drawing the attention of astronomers to certain questions which might otherwise escape their attention. Many resolutions concern only a single commission. These are usually

not formally proposed to the Union as a whole, but will be printed in the reports of commission meetings, in the *Transactions*. Among the resolutions of more general interest are the following:

By the Executive Council: 1. That the past president and general secretary remain members of the Executive Council in a consultative capacity. 2. That abstracts in a widely used language should accompany papers published in a language "that is not generally understood by astronomers." 3. That the Union regards it important that the remaining 17 volumes of the "Geschichte des Fixsternhimmels," the 15 volumes of the German photographic repetition of the A. G. Zones, and a new edition of the complete B.D. be published. But the Union allowed no funds for these undertakings, merely expressing the hope that "funds can be made available."

Commission 3 recommended that the list of notations in *Trans.*, **6**, 345-355, 1944, be more widely used.

Commission 4 recommended that the designation "Universal Time" be used to indicate mean solar time reckoned from midnight of the Greenwich meridian.

Commission 5 obtained a subsidy of 1500 gold francs for three years to aid the "Bulletin Mensuelle." The American opinions concerning the B. M. had been cool, to say the least. In response to our request the commission "looks forward to the publication of the *Jahresbericht* being continued regularly." No funds were requested by Professor Kopff and none were granted. The commission requested Professor Lundmark of Lund to publish his complete list of observatories and astronomers.

Commission 8 "views with pleasure the programs now in progress in the U.S.A. and the U.S.S.R. for connecting the system of the extragalactic nebulae with that of the fundamental stars."

Commissions 10, 11, 12, and 13, all dealing with problems of the sun, obtained varying amounts of financial support for such enterprises as the publication of heliographic charts of the photosphere by the Zürich Observatory, the publication of synoptic charts of the chromosphere at Meudon and the publication of the unpublished range (λ3063-λ6600) of the revised table of the solar spectrum by Babcock and Mrs. Sitterly. The American delegation felt let down by the complete lack of interest which these commissions and the Executive Council evinced in regard to the two proposals originally made by Menzel, namely that the functions of the four solar commissions be reviewed in the light of modern developments, and that the Union organize a special committee to revise all commissions before 1951. It might have been thought that these very modest American proposals would have carried more weight.

Commission 18 requested that its name be changed from "Longitudes" to "Determination of Geographical Positions."

COMMISSION 19 recorded its appreciation of the work of Professor Carnera of Capodimonte who had furnished a remarkably complete draft report embodying the results obtained in the study of variations of latitudes. This work will henceforth be conducted by Professor Cecchini in Turin, Italy. The Commission also commented upon the great usefulness of the photographic zenith tubes in this type of work, "not only for improving our knowledge of the motion of the pole, but also for providing much needed data in regard to the proper motions of the stars in declination, and for providing material for determining the constants of the solar system."

COMMISSION 20 recommended that periodic comet Pons-Coggia-Winnecke-Forbes should be designated in the future as Crommelin's comet. The Commission also recommended that the Minor Planet Center at Cincinnati be maintained, that it continue the publication of the *Minor Planet Circulars* and that beginning with 1950 it publish the annual volumes of ephemerides under the auspices of the IAU. This task had been assigned at Copenhagen in 1946 to the Leningrad Institute of Theoretical Astronomy, and a complete set of ephemerides for 1948 was delivered by the Russian delegation in Zürich. It was understood that the Soviet institutions were not anxious to carry indefinitely the entire responsibility for this enormous task. The 7 months delay in making available the 1948 emphemerides demonstrates the difficulty of this assignment. The Cincinnati center will assign provisional designations and permanent numbers to newly discovered minor planets, and will approve and assign the names proposed for them by their discoverers. Each annual volume of the ephemerides shall contain an appendix giving the basis for each set of elements.

COMMISSION 22 recommends the development of radar-methods of observing meteors which "is now essential to the proper advance of meteoric astronomy."

COMMISSION 23 requested the government of Australia to make possible the completion of the zones of the Astrographic Catalogue undertaken by the Australian observatories. The Commission also recommended the appropriation of 21,000 gold francs to cover the cost of printing of 5 volumes of the catalogue left incomplete by the Observatories of Potsdam and Rio de Janeiro, and for which the manuscripts were prepared by the Observatories of Oxford and Edinburgh. It is thus probable that this enormous international undertaking started almost 70 years ago will soon be completed. Despite the fact that in the meantime photographic instruments have been enormously improved the catalogue forms an invaluable source of material for accurate star positions. But, as Professor G. Van Biesbroeck had pointed out in a memorandum to the IAU the importance of the catalogue would be enhanced if it were to be supplemented by a uniform set of plate constants and reduction formulae.

COMMISSION 24 recommended the expenditure of $1500 to defray the cost of a new edition of the *Yale General Catalogue* of stellar parallaxes.

COMMISSION 27 organized a service whereby small charts will be made available to observers of newly discovered variables not easily identified in existing catalogues. The commission also adopted three resolutions proposed by H. N. Russell, J. E. Merrill, and N. L. Pierce: a) that observers publish all individual epochs of minima, in Greenwich mean time, reduced to the sun and expressed in decimal fractions of a day; b) that during the next two or three years the minima of all interesting eclipsing variables be re-determined, in order to cover as soon as possible the gap produced by the war. The observers should include not only systems with known apsidal motion, but also those which show fluctuations of period; c) that interesting eclipsing systems be observed simultaneously with the spectrograph and the photometer. The Commission emphasized the importance of spectrographic observations of variable stars in the southern hemisphere. It has approved for publication the 44th name list of variable stars by Kukarkin and Parenago.

COMMISSION 28 recommends the publication of Dr. C. O. Lampland's important nebular photographs secured at the Lowell Observatory and "it sincerely hopes that the necessary publication funds may be secured from some interested astronomical organization in America."

COMMISSION 29 recommended that a compilation and an atlas of molecular spectra in the laboratory, having an astrophysical interest, be prepared as soon as possible and requested the Vatican Observatory to investigate whether it could collaborate in this undertaking. The Commission discussed at length the proposed list of spectrographic standard stars prepared by Dr. A. H. Joy and decided to include this list in the report to be printed in the *Transactions*, with a few alterations. The Commission drew attention to the proposal of Professor Schwassmann that the entire sky be photographed with objective prisms attached to large Schmidt telescopes, and that information concerning the location of each series of photographs be circularized through the IAU.

COMMISSION 36 concerned itself among other things with the units of measuring line-intensities. The Commission recognized the usefulness of the unit $10^{6}\Delta\lambda/\lambda$, which had been proposed by Dr. Th. Dunham, Jr., and by the subcommission formed at Stockholm for considering this question. But the Commission decided "that for many problems the unit of equivalent width, $\Delta\lambda$, retains its value." Other units should be avoided, if at all possible.

COMMISSION 38 requested a grant of $1000 annually for the exchange of astronomers. This commission, under Prof. Stratton, has

already helped several young astronomers to carry on research in foreign countries. Although the results have been modest, they have come at a time when even the least amount of aid was of importance.

COMMISSION 39 on international observatories, under Dr. Shapley, submitted no formal resolutions, but decided to continue its work. The concensus is that ultimately a large observatory should be created in the southern hemisphere, but in the meantime Dr. Shapley favors the immediate organization of an international laboratory, in a small country of Europe (Switzerland or Denmark, for example) equipped not with telescopes, but with photometers, measuring machines, modern calculating machines, etc. Several large observatories would be asked to contribute photographic material in the form of direct photographs for photometric or astrometric purposes, objective prism photographs for spectral classification, etc. In addition, the laboratory should probably be provided with adequate funds for traveling expenses so that astronomers working under its auspices on special problems could, if necessary, visit some of the larger observatories in order to obtain material of a non-routine character. It is to be hoped that under Dr. Shapley's inspiring leadership at least a beginning will soon be made to carry out this important plan.

But international cooperation is by no means limited to Commissions 38 and 39. Despite the unfavorable political situation of the present time, the atmosphere of internationalism pervaded all the discussions, all the conferences, and all the speeches. To those who were able to make the trip to the Jungfraujoch, one of the most penetrating lessons of the success of international scientific cooperation was provided by the high-altitude observatory at which astronomers, meteorologists, cosmic-ray specialists, geologists, and many others, from various countries, work together in peace and harmony. Cut into the rock of the Sphinx, an outcropping above the glaciers of Aletch and Eiger, this laboratory is perhaps the most successful "melting pot" of scientists anywhere in the world. When I was there Dr. Chalonge could show me spectrograms obtained the night before by Mlle Moreau, one of his assistants from Paris. They had been developed by a young Swiss astrophysicist, and in all likelihood they will be useful, if only in an indirect way, to an American astronomer!

No less important is the growing international importance of the French Observatory of the Haute Provence. Astronomers from several countries in Europe are already using it, and the French hosts are receiving Danish or Dutch astronomers, while their own French astronomers spend an equivalent amount of time in Leiden, Copenhagen, or Oslo, doing theoretical work under the distinguished astrophysicists of these northern cities.

Then, there is the grandiose scheme of the Belgian government for a large scientific city, with observatory, as well as with other scientific

facilities, in the Belgian Congo, which Dr. Bourgeois, Director of the Observatory at Uccle, is trying to develop on an international basis.

And finally, there is talk of several international research projects, some of them sponsored by the new General Secretary, which should still further cement the ties of astronomers the world over. In a small way, such projects are already actively under way. Professor Swings of Liège, Belgium, is a Research Associate of the Yerkes and McDonald Observatories and is thus able to continue his work in stellar spectroscopy, in recognition of which he has just been elected chairman of Commission 29 (Stellar Spectra). And we, at Yerkes and McDonald, actively cooperate with the astronomers in Leiden by furnishing them tracings of spectra of RR Lyrae. Of course, there are many other, similar projects under way. Harvard's great contribution to Van Rhijn's work on the Selected Areas and Mount Wilson's generosity in allowing foreign astronomers to use some of their most valuable Coudé spectrograms all show that there has been no lack of international cooperation on the part of the American observatories.

At the meeting the spirit of internationalism hung over everything. I overheard one French astronomer trying to explain something in very broken English to another French astronomer, and I have caught myself speaking Russian to Swings, German to Ambarzumian, and French to Nassau! The American astronomers promptly caught from the Europeans the habit of shaking hands, so that at the end of the meeting we would shake hands with each other no matter how many times we met.

The local arrangements were perfect, and the amount of entertainment was almost embarrassing. The weather was rainy while we were in Zürich, but we had gorgeous weather on Sunday, August 15, when we were treated to an all-day bus-trip to one of the high mountain passes among snow-covered peaks. The weather was again perfect when we visited the Jungfraujoch.

The principal social occasion was a large banquet the night before adjournment. The principal address was given by Shapley who has permitted me to quote from his speech as follows:

> "Our indebtedness to our hosts in Switzerland, and especially in the Eidgenossische Technische Hochschule, is equalled by our obligation to this great small country for its example to a worried civilization in troubled times. Here we see long continued progress, prosperity, and peace, although the country is extremely heterogeneous in its people and their industries. Here we see democratically operated political cooperation, notwithstanding the conspicuous differences in language, religion, and racial origins. If we could only follow this example in world economy and in United Nations politics, then we would be assured of many more meetings of the IAU, and of an undisturbed future for the advance

cooperatively of astronomy and of other sciences. The astronomers can and should set a pattern, not only for the other sciences, but also for the diplomats. We are, to be sure, doing something directly through Commission No. 39 (international observatories), but more should be done. If the scientists throughout the world would recognize openly the insanity of war against fellow men, and join on a world-wide basis in a cooperative fight against the true enemies of civilized mankind—that is, join in the four-way war against poverty, disease, ignorance, and (the worst of all) baseless suspicion—then they would perhaps influence those who make foreign policies in these days of danger."

A few days after the meeting I was walking down from "Kleine Scheidegg" towards Grindelwald, through some of the most breath-taking scenery in the world. My companion was Dr. H. Slouka, Dircetor of the Stefanik National Observatory in Prague, Czechoslovakia—an experienced mountaineer who was on his way to Tyndall's old house at the base of the Aletch glacier. Slouka had spent four years in a German concentration camp because he had been previously acquainted with the late president Beneš. While we were resting on one of the wildly-beautiful mountain meadows he told me in effect the following: "I do not know how much you in America appreciate or value the efforts which your Dr. Shapley is constantly making towards world peace. Nor do I know whether the majority of the American astronomers would support his political views. But I want to tell you this, and I hope that you will tell it to your friends in America. We have suffered so much and have lost so many dear ones that our thoughts are all directed towards one thing only—the preservation of peace. Even the most fortunate among us have lost completely 10 years of their lives. What could we not have done in those 10 years! In our country we now have a communistic government, and many of my students are communists. You cannot realize how much it means to us that there is in America a great scientist who understands our problems and who wants, above all, to help preserve the peace. We, in the small countries of Europe, have little chance of survival, if the great nations, especially Russia and the United States, cannot agree. It is this that makes us so appreciative of Dr. Shapley's speech at the banquet." And a few days earlier I had another talk, this time with an astronomer from Germany, Dr. F. Becker of Bonn. He told me substantially the same thing: "Among the heaps of rubble which surround us we think more and more of the value of science to society and of its effect in securing permanent peace. What is the use of developing science for its own sake, if it can all be destroyed in a few minutes of heavy bombing?"

There was one occurrence at the banquet which was strange to the western astronomers, and probably frightening to some. After we had all been seated in the large dining hall of the Zürich Kongresshaus,

suddenly one of the Soviet delegates got up from his place and shouted something across the room to his countrymen. From the place where I was sitting I could not hear the actual words, but everyone noticed that the Soviet delegates got up from their places and left the room. A few minutes later we noticed that a workman appeared on the stage where there was a display of the flags of many nations. He removed the Swiss flag and substituted for it the Soviet flag—which had apparently been missing. Then, a few minutes later Professor Mikhailov re-entered the room, and with him came the rest of the Soviet astronomers. The international incident was over, and the meal was enjoyed by all! That this silly incident should have drawn a certain amount of applause from the rest of the audience is an indication of the bewilderment which grasps the whole world. The incident itself accomplished nothing. It was undoubtedly a regrettable oversight that the Soviet flag had been omitted—but after all, the Soviet delegates were late in arriving, and in all probability the list of nations given to the managers of the dining room was the printed one in which the Russian astronomers were not listed as having accepted. On the other hand, this incident serves to focus our attention upon the fact that the IAU is an international organization and that we must not expect everyone to behave exactly as we do. (*After* the incident several representatives of other nations also became aware of the fact that their flags were missing, but no one else left the room!) In a strange way this incident brought back to my mind half-forgotten recollections of the behavior of the Russian people. The younger Russian astronomers were undoubtedly former army officers, and I suspect that the incident, far from being intended as an insult to others, was merely a kind of "esprit de corps," silly perhaps by our standards, but noble and genuine by theirs.

At any rate, everybody who had any relations with the Soviet astronomers during the meetings found them kind and understanding and unassuming. Kukarkin and Zverev had brought with them several copies of the new *Russian Catalogue of Variable Stars,* the first such catalogue since Schneller's last in 1941. They also distributed copies of several new issues of their important periodical "Peremennye Zvezdy" (formerly known as "Veränderliche Sterne"). Unfortunately, a recent ruling of the Soviet government had made it necessary to print everything in Russian, without even an abstract in another language. The patriotic motives underlying this decision may be understandable, but the loss to international cooperation will be great. Many persons have already made efforts to learn the Russian language. It is to be feared that these efforts will not be accelerated by this new departure. As a friendly move towards all those who genuinely admire Russian astronomy and wish to make use of it a reversal of the new ruling would accomplish wonders.

During the last session Professor Mikhailov confirmed his earlier,

telegraphic invitation to the IAU to meet in Leningrad in 1951. He spoke in Russian (his speech was later translated into English and French) and he described the efforts which are being made to rebuild the great Pulkovo Observatory—once the capital of astronomy, according to B. A. Gould—which was so wantonly destroyed by the German fascist invaders. In 1951 the Observatory would again be ready for research, and the time would be appropriate to hold the meeting near it.

Some months before the Russian invitation had been confirmed (there had been some vague talk about a meeting in the Soviet Union in 1951 or 1954, when the organizational committee met at Copenhagen in 1946) the USA National Committee of the IAU, the National Research Council in Washington and the Director of the Palomar and Mt. Wilson Observatories had sent a tentative invitation to the Union to meet in Pasadena in connection with the completion of the 200-inch telescope. Our attitude was then and still is that we should like to have the IAU come to America in 1951 or at some other time, but that we do not propose to compete with the invitation from the Soviet Union. Most of us feel that their invitation, having been tentatively made in 1946, has an earlier claim and should be given first consideration. Only if for reasons not now apparent the Union should decide not to go to Leningrad would our invitation at all come under consideration. And even then, the difficulties of dollar-exchanges for most of the European countries would be so great that no definite acceptance would be possible for some time.

The Executive Council had, very wisely, decided to invite to Zürich a number of individual German astronomers. Professor Kopff of Heidelberg was especially welcomed by Sir Harold Spencer Jones in his opening speech at the start of the meeting. Dr. A. Unsöld of Kiel took part in the symposium on atomic abundances, and Dr. K. O. Kiepenheuer spoke in one of the sessions on solar and terrestrial relationships. Dr. O. Heckmann of Bergedorf, Dr. H. Kienle of Potsdam, and Dr. F. Becker of Bonn all took a more or less active part in the discussions. The contribution of German science to the IAU has thus been recognized and it is this that matters. But a word of caution may not be amiss: the integration of German scientists within the IAU must be a slow process. There are many who would resent a meeting on grounds other than professional, and it will require a great deal of tact, on both sides, not to overstep the boundaries of decency. I am not entirely certain that these boundaries have been sufficiently respected at Zürich. To break them down prematurely may cause grief to some and disgust to others.

Some Comments on the Future of Positional Work in Astronomy

By W. J. LUYTEN, J. SCHILT, and P. VAN DE KAMP

Introduction

During the past few years there appears to have been a growing feeling that stellar parallax work has virtually come to an end. This has been expressed not only by parallax observers or observatories engaged in parallax work, but likewise by spectroscopists who appear to feel that the existing parallax material provides a sufficiently broad base from which extensions may be made by spectroscopic and other astrophysical techniques alone for a long time to come.

In consequence of this the amount of observing time devoted to parallax, proper motion, and other positional work is almost negligible where the three or four largest telescopes now in operation are concerned. While the authors of the present statement feel that in so far as a short-time policy is concerned concentration on new astrophysical techniques—especially with the most powerful telescopes—would in the immediate future lead to results of greater importance than mere continuance of positional work, they are convinced that long-range neglect of positional work would be a calamity of the first order, leading to disastrous consequences in the very fields of astrophysics which are now being favored.

For the purpose of attempting to slow down or reverse this present tendency the authors, in the order indicated at the beginning, are herewith presenting a discussion of present and future problems in positional astronomy together with suggestions and recommendations for observations to aid in their solution.

I

A. *Parallax work.* None of the visual and photographic refractors currently used for the determination of stellar parallaxes can feasibly be employed for stars fainter than the 14th magnitude as exposures are too long, and all our information on parallax of fainter stars has virtually been obtained through van Maanen's work with the 60 and 100-inch telescopes. While it is true that reflector parallaxes are subject to much greater uncertainties than those determined with refractors, this decrease in accuracy is certainly no more serious than that in radial velocity measurements of stars of the 16th magnitude as compared with those of stars of the 12th magnitude, and in neither case could it justifiably be used as a deterrent against making the observations. In final analysis even an inaccurate parallax is better than none at all. Among the several classes of objects deserving of attention from parallax observers with large telescopes are:

1. White Dwarfs and Degenerate Stars. Ninety-two of such objects are now known. 58 fainter than $14^m.0$ (pg or pv). Reliable trigonometric parallaxes are known for only 21, including 5 fainter than $14^m.0$.

More specifically, there may be singled out the group of 20 white dwarfs which are components of binary systems. Parallaxes are known for only 5 of these, and 12 of the remainder are fainter than $14^m.0$. In addition to parallaxes accurate relative positions for these stars should be obtained over several decades in the hope of determining orbital motions and mass-ratios since these are the only systems from which ultimately the individual masses of white dwarfs can be determined. At present only two such white dwarf masses are known; yet until masses of many of them become known our theories of white dwarf structure are not likely to advance beyond their present tentative stage.

2. Stars intermediate in luminosity between the main-sequence and the white dwarfs, especially in spectral classes A-G. At present hardly a single reliable parallax is known for such stars and we are still at a loss to know whether these stars form a well-defined sequence in the spectrum-luminosity diagram or whether they are merely scattered over most of the region on the dense side of the main sequence. Several hundreds of these stars have been indicated from spectroscopic or color criteria, most of them fainter than $13^m.0$ p.g.

3. Stars of very low luminosity. Although many thousands of faint stars with large proper motions are known, parallaxes have been determined for only a few of them. To fix ideas, it might be pointed out that there probably are some 6,000 stars in the sky fainter than $15^m.0$ pg and with motions larger than $0''.3$ annually, about 1,000 of which are known. Until parallaxes have been determined for a well-distributed representative sample of them we shall be unable to determine the space frequency of stars below absolute magnitude $+14$.

B. *Proper Motions.* Among the several desiderata in this field two may be mentioned.

1. The completion of the survey for large proper motions over the entire sky. While this survey is virtually complete down to $14^m.5$ pg in the southern hemisphere there are still large areas in the north where few if any large proper motion stars are known fainter than $11^m.5$ and even in the areas which have been examined the lack of homogeneity is serious. Most of this work could be undertaken with telescopes of moderate size (and large fields).

2. A survey for large proper motions as well as a determination of the systematic motions of stars down to magnitude 19 or 20—an extension of the plan of Selected Areas. This can obviously be accomplished only with the largest telescopes now in operation but its results will be of the greatest importance in connection with the structure and the dynamics of the Galactic System as well as with the determination of the faint end of the luminosity function.

Owing to the considerable amount of time which must elapse before second-epoch plates can be taken, the inception of both programs (1) and (2) should not be delayed if results are to be obtained in the not too distant future.

II

1. The feeling has been expressed that interest in stellar parallax work is decreasing, and that several astronomers take the position that further work on trigonometric parallaxes would not be as important and urgent as other phases of astronomical research.

2. The fundamental importance of the trigonometric parallaxes in problems of galactic structure and dynamics, and in problems of astrophysics will not be doubted by anyone. It may, however, appear to some that the data so far obtained are already sufficient for the needs of these problems, and that comparatively little can be gained by extending the observing programs. The writers of the present memoranda believe that observations of trigonometric parallaxes should be encouraged with a view to extending the programs and improving the accuracy.

3. Dr. Luyten has pointed out the needs for observations of faint stars with proper motions and from this it appears that for the faintest stars not even a first knowledge can be had unless cooperation from the big telescopes is obtained.

4. Individual accuracy of parallaxes can be increased by special techniques such as reversing the plate, as stated by Dr. van de Kamp in the following section.

5. I should like to dwell upon a matter that has been of less interest so far but which may well develop into a revaluation of parallax results. The large differences between results obtained at different observatories for the same stars have perhaps had a discouraging influence. It should be a rather exasperating experience to obtain a parallax from good plates with a probable error of say 0".007, expertly measured and reduced and deserving the fullest confidence, and to find that it differs some 0".040 or more from the value equally confidently derived from a different set of plates at another observatory. Several astronomers have spent a good deal of effort on the problem of these systematic differences. If comparatively little has been published, this is, if I may generalize from my own case, because of the unsuccessfulness of the results. Temperature gradients in the glass causing differences between the evening and the morning observations and atmospheric conditions causing lateral refraction may still be considered as possible sources of small systematic errors. They cannot, however, be the sources of large errors occurring as frequently as in parallax work. To account for these errors, one experiment that seems not to have been made so far and which would be quite feasible would be for two observatories to remeasure some of the parallax stars that they have

in common, each using the other's comparison stars. This could perhaps not be done in all cases, but there should be a number of stars where the comparison stars used by another station would be measurable and could be measured instead of the original comparison stars. In this way, it would be virtually impossible to find cases where the images of the parallax stars and comparison stars would be equal. The probable error would therefore certainly be larger than for the original measurements, but there seem to be a sufficiently large number of stars, parallaxes determined at two or more stations, which differ by, say, 6 or 7 times the probable errors. If differences of that order are frequently due to differences in parallax of the comparison stars, this would be the way to find out.

III

A. *General.* The need for continued parallax determinations of faint proper motion stars is obvious. In many cases this work can be done as well by visual as by photographic refractors, because of the tremendous increase in the speed of panchromatic emulsions during the past few decades. In addition, one has the advantage of decreased atmospheric dispersion. The astrometric potentialities of the large reflectors should be carefully studied.

It is important that series of plates on binary stars be continued both for the purpose of parallax and mass-ratio. A number of spectroscopic and eclipsing binaries should be observed, in the hope of establishing apparent orbits.

Continued long-range surveys of nearby stars are important to find perturbations due to companion objects.

B. *Accuracy.* In order to reduce film errors, so-called "double plates" should be taken; a double plate is obtained by turning the same photographic plate 180° in its own plane between two successive sets of exposures.

One limit to higher positional accuracy is due to differences in the colors of stars. There is little that we can do about atmospheric dispersion except through proper choice of emulsion and filter. Improved mounting of the objective may reduce the effect of transverse chromatic aberration, presumably due to slight shifts, or distortions, of the component lenses of the objective.

A knowledge of the magnitudes and spectra of the reference stars is desirable, while for long-range investigations the choice of reference configurations should be carefully made, to accommodate the extended paths of stars of large proper motions.

Intense overall coverage of the parallactic orbit over all parallax factors, and measurements in both right ascension and declination, may shed light on the problem of systematic errors in parallaxes.

C. *Survey vs. Precision Parallaxes.* While on the one hand there seems to be every reason to continue "conventional" parallax determin-

ations for the numerous faint, large proper-motion stars, it appears desirable to make a number of stars the subject of intensive individual parallax determinations. The conventional determinations based on some twenty or thirty plates taken at large parallax factors, may be called "survey parallaxes." For the individual determinations of "precision parallaxes" no upper limit to the number of plates need be set.

There are numerous individual stars, and I am thinking primarily of binaries and white dwarfs, for which very accurate parallaxes are desirable. One way to increase the accuracy would be to have the star observed at different observatories. The other approach lies in increasing the number of plates taken for any one parallax series of plates. There certainly is no reason to attach any particular significance to the conventional number of twenty or thirty plates. It may very well be that the law of diminishing returns does not begin to become effective until several hundred plates have been taken.

I am convinced that such intensive series of plates must be taken and that they can lead to a considerable improvement in accuracy. At the same time, as mentioned above, a better understanding of attainable accuracy may be reached.

Mars, Jupiter, and Saturn: Approximate Conjunctions

By R. B. WEITZEL

A conjunction of Mars and Saturn occurs every two years, whereas a conjunction of Jupiter and Saturn occurs every twenty years. The conjunction may be in geocentric longitude or in right ascension.

Conj. of Mars and Saturn in geocentric longitude	Conj. of Mars and Saturn in right ascension
1940 II 11, 14^h	1940 II 13, 8^h
1942 II 22, 10	1942 II 24, 2

Geocentric conjunctions will be discussed in this paper. The computation of data, sufficiently accurate for the purpose in view, is based on the Greenwich midnight which follows or precedes a conjunction of Mars and Saturn, as illustrated with the inclusion of Jupiter.

G.C.T.	0^h	☉	Mλ	Jλ	Sλ	Diff.
1940	II 12	322°1	26°6	8°1	26°3	−18°2
1942	II 22	332.7	52.2	71.8	52.4	+19.4

The last column marks the difference between the geocentric longitudes of Jupiter and Saturn. To exemplify further Jλ—Sλ, twenty conjunctions of Mars and Saturn for two centuries are presented in pairs.

G.C.T.	0h	Sλ	Jλ—Sλ	G.C.T.	0h	Sλ	Jλ—Sλ
1801	VII 11	142°0	—13°1	1899	XII 7	264°8	—28°8
1803	VIII 3	168.4	+14.2	1901	XII 15	285.8	+ 1.7
1821	V 5	20.0	— 4.5	1919	X 24	158.6	—23.2
1823	V 19	45.2	+28.5	1921	XI 13	184.1	+ 5.8
1841	X 17	268.2	—11.2	1940	II 12	26.3	—18.2
1843	X 18	289.7	+28.0	1942	II 22	52.4	+19.4
1861	IX 11	163.6	— 3.6	1960	II 1	283.0	—17.8
1863	X 2	188.6	+22.8	1962	II 7	304.0	+15.1
1879	VII 1	15.1	—32.4	1980	VI 24	170.9	—16.5
1881	VII 6	40.4	+ 8.6	1982	VII 7	195.6	+14.9

A hundred and fifty approximate conjunctions of Mars, Jupiter, and Saturn, within ten degrees of geocentric longitude, were located for a period of more than five thousand years. During the process of the investigation, an irregular interval of 854 years was employed to schematize the conjunctions. For illustration, two selected series are skeletonized.

G.C.T.	0h	Jul. Day	Jλ—Sλ	G.C.T.	0h	Jul. Day	Jλ—Sλ
—3620	VIII 21	399086	—2°7	—3401	X 21	479136	+7°0
854		311899		854		311903	
—2766	VII 28	710985	—2.4	—2547	IX 30	791039	+5.5
854		311899		854		311900	
—1912	VII 3	1022884	—2.5	—1693	IX 17	1102939	+4.1
854		311900		854		311756	
—1058	VI 10	1334784	—3.0	— 839	III 23	1414695	+6.8
854		311899		854		311882	
— 204	V 16	1646683	—3.6	15	II 10	1726577	+4.8
854		311897		854		311900	
650	IV 20	1958580	—4.5	869	I 17	2038477	+2.6
853		311736		854		311904	
1503	X 15	2270316	—3.0	1723	I 9	2350381	+0.5

This interval of 854 years is very irregular, and must be used with caution. To show its irregularity, some variations of the interval are supplied

Mean interval	311.901 ± 4^d	(70% of cases)
Minor variant	311.888 ± 8	(15% of cases)
Major variant	311.742 ± 14	(15% of cases)

The best interval that was encountered in the course of the study is a long-term period of 3773 years, thus formed from synodic revolutions of the planets expressed in terms of tropical years.

Mars	2.13539×1767^y	$= 3773.234^y$
Jupiter	1.09211×3455	$= 3773.240$
Saturn	1.03518×3645	$= 3773.231$
Mean interval in days	1378.145 ± 4^d	

The general character of this interval, with reference to the advance in geocentric longitudes of the planets and the small change in the dif-

ference between the longitudes of Jupiter and Saturn, or Jλ—Sλ, may be seen from the following examples.

G.C.T.	0h	Jul. Day	☉	Mλ	Jλ	Sλ	Jλ—Sλ
—2270	VIII 15	892167	122°.3	22°.0	19°.8	22°.2	—2°.4
3773		1378149		85.8	85.0	85.6	—0.6
1503	X 15	2270316	210.1	107.8	104.8	107.8	—3.0
—1872	X 10	1037593	181.8	202.4	205.5	202.3	+3.2
3773		1378141		83.6	82.0	83.5	—1.5
1901	XII 15	2415734	262.3	286.0	287.5	285.8	+1.7

This interval of 3773 years can be applied to solar oppositions of Mars, Jupiter, or Saturn, as will be exemplified.

Mars Opp.	G.C.T.	Julian Day	☉	M to J
—2270	X 31, 18h	892244.75	202°.22	—5d 12h
3773		1378143.87	81.77	
1503	XII 26, 15	2270388.62	283.99	—4 1
Jup. Opp.				J to S
—2270	X 26, 6	892239.25	194.60	+3d 14h
3773		1378145.33	85.27	
1503	XII 22, 14	2270384.58	279.87	+4 10
Sat. Opp.				M to S
—2270	X 29, 20	892242.83	198.78	—1d 22h
3773		1378146.17	85.58	
1503	XII 27, 0	2270389.00	284.36	+0 9

In 26 B.C., Mars, Jupiter, and Saturn were at solar opposition on January 12, 18, and 22, respectively. A single conjunction of Mars and Saturn occurred April 26, on redirect motion, with a difference of —5°.2 between the geocentric longitudes of Jupiter and Saturn. It happened in this instance that the planets were closer together, with a difference of —3°.3, on the previous December 6, a few days after the first stationary point of Mars.

A table of the approximate conjunction of Mars, Jupiter, and Saturn, within five degrees of geocentric longitude, from 563 B.C. to 2000 A.D., has been prepared. The columns give in order, year, month, day at zero hour of Greenwich Civil Time, Julian day number, place of Sun, longitudes of Mars, Jupiter, and Saturn, and finally, the difference between Jλ—Sλ. Asterisks are used in nine cases to indicate invisibility of Mars on account of nearness to Sun.

G.C.T.	0h	Jul. Day	☉	Mλ	Jλ	Sλ	Diff.
—562	VI 12	1515950	73°.2	33°.2	30°.1	33°.5	—3°.4
—542	XI 4	1523400	215.9	269.2	265.1	269.5	—4.4
—522	X 23	1530693	203.9	173.6	169.5	173.8	—4.3
—383	V 28	1581315	60.5	*61.1	58.0	61.2	—3.2
—363	IV 21	1588583	25.4	301.7	305.1	301.8	+3.3
—343	IX 30	1596050	182.2	*195.8	192.6	195.8	—3.2
—204	V 16	1646683	50.7	89.0	85.5	88.9	—3.4
—164	VIII 31	1661400	153.9	217.5	216.2	217.4	—1.2
— 26	XII 6	1711901	252.2	120.3	120.6	123.8	—3.2
15	II 10	1726577	319.3	248.4	253.5	248.7	+4.8
35	VII 7	1734029	101.4	137.7	142.3	137.6	+4.7
113	VI 9	1762491	75.8	8.5	5.8	8.8	—3.0
153	X 18	1777232	203.9	153.7	149.9	153.6	—3.7

G.C.T.	0^h	Jul. Day	☉	M☌	J☌	S☌	Diff.
214	VI 13	1799385	80.1	165.0	168.6	165.0	+3.6
292	V 19	1827850	57.4	*38.0	34.6	38.1	−3.5
332	X 1	1842595	188.4	*179.4	174.5	179.5	−5.0
471	V 4	1893214	43.8	66.1	61.8	66.2	−4.4
491	III 27	1900481	7.2	309.8	310.2	309.8	+0.4
511	IX 11	1907954	169.1	202.8	197.8	202.8	−5.0
650	IV 20	1958580	31.9	94.6	90.2	94.7	−4.5
670	II 24	1965830	338.3	*332.9	336.2	332.9	+3.3
690	VIII 2	1973294	130.4	225.5	222.2	225.8	−3.6
828	X 8	2023766	199.1	130.3	128.4	130.6	−2.2
869	I 17	2038477	301.9	255.8	258.8	256.1	+2.7
889	VI 12	2045928	84.7	143.5	148.2	143.8	+4.4
967	V 16	2074390	59.1	14.4	11.0	14.3	−3.3
1007	IX 24	2089131	185.7	158.9	155.4	158.7	−3.3
1047	XII 21	2103829	274.9	*278.6	282.5	278.7	+3.8
1146	IV 26	2139750	41.5	*42.3	38.5	42.5	−4.0
1246	XI 7	2176470	231.9	204.6	209.1	204.5	+4.6
1325	IV 10	2205114	27.7	70.8	66.6	70.9	−4.3
1345	III 6	2212384	353.5	317.4	314.9	317.2	−2.3
1425	X 16	2241828	211.3	*227.5	232.6	227.7	+4.9
1503	X 15	2270316	210.1	107.8	104.8	107.8	−3.0
1524	II 5	2277734	325.1	339.5	340.4	339.6	+0.8
1544	II 2	2285036	322.2	241.3	239.3	241.3	−2.0
1682	IX 22	2335663	179.3	136.4	134.0	136.2	−2.2
1703	I 15	2343082	294.2	4.0	7.9	4.1	+3.8
1723	I 9	2350381	288.3	263.5	264.0	263.6	+0.4
1821	V 5	2386291	45.1	19.8	15.5	20.0	−4.5
1861	IX 11	2401030	168.2	*163.3	160.0	163.6	−3.6
1901	XII 15	2415734	262.3	286.0	287.5	285.8	+1.7
2000	IV 15	2451650	25.4	46.7	42.5	46.8	−4.3

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The Planets in November, 1948

By RAYMOND H. WILSON, JR.

Note: The time employed is Central Standard Time unless otherwise indicated. The phenomena have been chosen and described for the North American continent, and especially for the United States. The basic data have been taken principally from the *American Ephemeris and Nautical Almanac*.

Sun. The sun will continue its rapid southerly trend in declination, reaching almost 22 degrees south at the end of the month. There will be a total eclipse at New Moon just after midnight on November 1, which therefore will be visible only from opposite regions of the earth, such as East Africa.

Moon. The phases of the moon will occur as follows:

New Moon	November 1	12 A.M.
First Quarter	8	11 A.M.
Full Moon	16	1 P.M.
Last Quarter	23	3 P.M.
New Moon	30	1 P.M.

Perigee will occur on November 25.

No bright stars will be occulted.

Evening and Morning Stars. Jupiter and Mars will be fading in the evening twilight, while Venus and Saturn will be rather conspicuous in the morning sky.

Mercury. An elongation of 19 degrees to the west of the sun will cause Mercury to be observable in the early morning twilight during the first week or ten days of this month. It will then be located about 5 degrees north of Spica, and will be much brighter than that star.

Venus. After its rising in the east at about 4 o'clock every morning, Venus will be the most conspicuous star in the sky. Its position relative to the sun will be quite favorable for observation, since it will reach altitude of over 30 degrees before sunrise.

Mars. In its long, close race with the sun Mars will still be almost two hours ahead to the east. However, its extreme southern declination and comparative faintness will make it difficult to observe in the southwest twilight. Close proximity of its similar namesake, Antares, to its southwest will not decrease this difficulty; but the young moon just 3 degrees to the south on November 3 might help to identify the planet.

Jupiter. This brilliant planet will continue to be conspicuous in the southwest during early evening hours.

Saturn. By the end of the month Saturn will be rising at midnight. It will thus be favorable for morning observation in the constellation Leo.

Uranus. Uranus will be moving slowly westward, less than a degree to the northeast of 1 Geminorum.

Neptune. On November 12 Neptune will be only half a degree south of Venus; and, on November 26, about the same with reference to the moon.

Department of Mathematics, Temple University, Philadelphia, Pa.
September 4, 1948.

Asteroid Notes

By HUGH S. RICE

Ephemerides of minor planets for 1948 have been computed at a number of different places including the U. S., Germany, Russia, and Japan. No one of the institutions concerned has as yet published the entire set. The German headquarters at Heidelberg printed a fairly comprehensive set in two parts, and the arrangement and printing are nicely done. The International Astronomical Union has made plans recently by which the 1949 ephemerides are to be published by the Cincinnati Observatory in much the same way as the 1947 set was, that is, following the style of the old *Kleine Planeten.* The computing will not all be done at the Cincinnati headquarters, inasmuch as the entire work is a large undertaking.

We had not, unfortunately, received the JUNO ephemeris until recently; but we give herewith a few places in the hope that observers may pick up this one of the "big four" and observe same. It will be advisable to follow this planet by observation alone, after our short ephemeris runs out, as we have no more predicted places. The last place (for Oct. 24) is uncertain, for the original apparently contained an error, which we have attempted to correct. Opposition occurs around October 1, and the magnitude is given as 7.5, which is particularly bright for JUNO. These magnitudes are supposedly photographic. In 1944 JUNO's visual magnitude was 1.5 brighter than the photo-magnitude. Assuming the relation

holds now, the visual magnitude would be 6.0, which is altogether unreasonable for this planet, seemingly. We hope that in time these matters will be straightened out and that the data will be reliable. Computations at present are more difficult than normally, and likely will be, until observations themselves have again established better elements on which to base the ephemerides. Meanwhile, considerable progress is being made in the entire asteroid program of computation and observation.

JUNO is in western Cetus; JULIA is near Gamma Andromedae, magnitude about 9, visually; PROKNE is in central Cetus, magnitude about 9½; and RACHELE is near Mira, magnitude 10. In November and December we shall be fortunate in having PALLAS around again, but not too fortunate, for PALLAS will be found south of Lepus and hence not particularly easy for observers around $\phi = +40°$. We have however some followers farther south. In Cairo, Egypt, a keen interest in asteroid observing appears to have sprung up, headed by one I. Debono, and we expect to hear more from this interested group later.

ASTEROID EPHEMERIDES

For 0^h U.T. Equinox of date (1950 for No. 674)

3 JUNO

1948	α h m	δ ° ′
Sept. 30	0 42.1	— 3 24
Oct. 8	0 36.9	— 5 10
16	0 31.3	— 6 48
24	0 25.5	— 8 8

89 JULIA

1948	α h m	δ ° ′
Oct. 8	2 35.9	+43 25
16	2 28.5	+43 57
24	2 19.6	+44 1
Nov. 1	2 10.2	+43 39
9	2 1.2	+42 52
17	1 53.6	+41 42

194 PROKNE

1948	α h m	δ ° ′
Sept. 30	1 40.0	—10 15
Oct. 8	1 34.6	—12 8
16	1 28.7	—13 43
24	1 23.0	—14 55
Nov. 1	1 18.1	—15 41
9	1 14.4	—16 2

674 RACHELE

1948	α h m	δ ° ′
Oct. 8	2 13.4	+ 0 41
16	2 6.5	+ 0 29
24	1 59.0	+ 0 22
Nov. 1	1 51.4	+ 0 23
9	1 44.1	+ 0 33
17	1 37.7	+ 0 52

Hayden Planetarium, American Museum of Natural History, New York, September 21, 1948.

Occultation Predictions for November, 1948

(Taken from the *Amerian Ephemeris*)

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 miles of the point indicated. The procedure is as follows: Subtract the longitude of the point given from the longitude of the place in question; multiply the result in degrees, taking the signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude, using *b*; apply the sum of the products, with its proper sign, to the Greenwich C.T., and obtain the predicted Greenwich Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to subtract five hours; Central Standard Time, six hours, etc.

Date 1948	Star	Mag.	IMMERSION Greenwich C.T.	*a*	*b*	Angle E from N	EMERSION Greenwich C.T.	*a*	*b*	Angle E from N
			h m	m	m	°	h m	m	m	°
Occultations Visible in Longitude +72° 30′, Latitude +42° 30′										
Nov. 4	210 B.Scor	6.0	22 11.9	−2.2	−2.1	137	23 0.2	−0.3	+0.2	216
8	86 B.Capr.	6.2	2 31.7	..	..	148	2 38.0	..	..	159
14	263 B.Pisc	6.4	7 21.8	−0.5	+0.9	29	8 14.8	−0.2	−1.8	278
18	BD+26°884	6.5	23 53.5	+0.2	+1.1	93	0 44.5	+0.3	+1.7	239
19	136 Taur	4.5	7 15.1	..	..	24	7 54.3	..	..	328
21	ω Canc	5.9	8 58.4	−1.6	−2.0	133	10 10.2	−1.9	−0.3	263
Occultations Visible in Longitude +91° 0′, Latitude +40° 0′										
Nov. 8	86 B.Capr	6.2	1 49.8	−2.2	−1.3	98	2 52.0	−0.1	+0.8	205
9	143 B.Capr	6.2	2 44.4	−1.2	0.0	59	3 59.4	−0.6	−0.2	235
10	56 Aqar	6.4	4 19.8	..	..	345	4 44.6	..	..	305
14	263 B.Pisc	6.4	7 5.9	−0.9	+1.3	29	8 9.2	−0.9	−1.4	269
19	136 Taur	4.5	6 39.0	−0.8	+4.5	23	7 23.8	−2.7	−3.1	318
19	415 B.Taur	6.1	10 43.6	−1.8	+0.1	64	11 46.2	−0.5	−2.3	305
21	ω Canc	5.9	8 33.8	−1.8	−3.4	155	9 23.9	−2.5	+3.2	229
Occultations Visible in Longitude +98° 0′, Latitude +30° 0′										
Nov. 8	86 B.Capr	6.2	1 45.0	−3.6	−1.8	111	2 37.6	+0.5	+2.4	188
9	143 B.Capr	6.2	2 32.8	−2.0	+0.1	69	3 51.9	−0.6	+0.8	219
10	56 Aqar	6.4	3 54.9	−0.1	+2.3	10	4 54.7	−1.8	−1.2	272
11	ψ^1 Aqar	4.5	5 28.0	+0.8	+3.9	354	6 6.2	−2.2	−2.9	291
11	ψ^2 Aqar	4.6	6 10.5	−1.6	−1.6	96	7 2.2	+0.2	+2.0	192
12	29 Pisc	5.2	7 51.7	..	..	345	8 10.8	..	..	311
14	263 B.Pisc	6.4	6 47.6	−1.7	+0.7	57	8 7.2	−1.1	+0.4	235
19	136 Taur	4.5	6 1.6	−1.1	+2.2	53	7 18.0	−2.5	−0.1	280
19	415 B.Taur	6.1	10 36.8	−1.8	−1.4	105	11 54.9	−1.4	−0.7	264
Occultations Visible in Longitude +120° 0′, Latitude +36° 0′										
Nov. 5	38 B.Sgtr	4.7	2 13.6	−1.0	−0.4	63	3 21.3	−1.0	−1.5	282
8	86 B.Capr	6.2	0 46.2	−2.2	+1.1	62	2 19.1	−2.1	+0.3	248
9	143 B.Capr	6.2	2 6.9	−0.8	+2.4	12	3 12.2	−3.1	−0.9	281
11	ψ^2 Aqar	4.6	5 40.4	−1.0	+1.1	36	6 56.9	−1.2	−0.2	245
14	263 B.Pisc	6.4	6 36.6	+0.4	+4.3	352	7 22.6	−3.4	−2.3	288
19	415 B.Taur	6.1	9 43.9	−2.3	+0.2	88	11 10.8	−2.2	−0.2	265
21	ω Canc	5.9	7 46.8	−1.8	−1.8	150	8 25.5	−0.3	+4.1	218

METEORS AND METEORITES

Meteor Notes from the American Meteor Society

By CHARLES P. OLIVIER, President

The recent return of the Perseids seems, from reports received so far, to have been below the average in hourly rates and exceptional meteors. This, however, is a purely casual remark because these reports have not actually been studied and no rates have been derived, and many, of course, have not yet reached us. Therefore, a more complete analysis may well cause a modification of the opinion stated above. For myself, I observed nothing, being sick during the week of maximum, but the weather here was so far from favorable that little would have been seen in any case. Cloudy skies seem to have been rather prevalent over most of the Atlantic seaboard states, though here and there persons had good weather for one or more nights.

The Perseids, however, have just been subjected to perhaps their most extensive theoretical study. The articles began to appear in the May-June, 1947, number (Vol. XXX, No. 5/6)[1] of the *Journal des Observateurs*, and are by G. Gurgay of the Marseilles Observatory. The last paper appeared in the January, 1948, number, and indeed completely fills it. Later on, when these excellent articles have been more fully studied, I hope to add more remarks, but a few may be in order at once. In the *Memoirs of the R.A.S.*, Vol. LIII, W. F. Denning gave an ephemeris of the Perseid radiant running from July 11 to August 19, inclusive. Gurgay proceeds to test, first by a variety of theoretical methods, then by using available photographic results, whether indeed it is justifiable to consider that a single meteor current *can* or *does* have such an enormous width, as would be necessary for a 40-day duration, which amounts to one-ninth the whole circumference of the Earth's orbit. (We may interpolate here that A.M.S. results have seemed rather to confirm a duration of from July 28 to August 18, inclusive. Even this so so long that one may well be troubled at such a duration.) Gurgay proves that the classic equation of Callandreau (*C. R.*, 112, 1304), which is copied in my book "Meteors," p. 207, does not prove that when the latitude β of radiant varies little then the same will be true for $\lambda - \odot$, where λ is the radiant's longitude and $\odot$ the longitude of the Sun. Callandreau apparently thought his proof correct, and his opinion was copied by me, as my book was partly a general review of former work and it was utterly impossible to attempt, in most cases, to go through in detail the work of men of high reputation, when there was no obvious reason to doubt their results. Gurgay also shows that only two planets, Earth and Saturn, come near enough to the Perseid stream to produce strong perturbations. He further shows that neither one nor both could produce sufficient changes in direction for separate meteors which would account for a 40-day duration. The second part of his work deals with curves of theoretical frequency, and on the basis of these he comes to the following result which is freely translated: "We will conclude then in the existence of the Perseids during all the period going from July 23 to August 23, without it being possible for us to formulate an opinion for the period before July 23." It must not be assumed from this, I believe, that Gurgay affirms or thinks that the shower *actually* lasts that long, only that so far as this theoretical approach is concerned, it might. His further conclusions will be discussed in later "Notes."

Thanks to a special appropriation from the Faculty Research Committee Fund of the University of Pennsylvania, we were able to secure the services of Miss Nancy E. Weber, assistant in Whitin Observatory, Wellesley College, for the summer. She has concentrated on helping with the reduction of reports on fireballs and preparing papers in which the atmospheric paths and, when possible, the orbits are worked out. Fireballs with large numbers of reports usually have been given preference. Some of these have had to remain in our files, unreduced, for several years. She has finished a number of cases, some done almost independently, the others in collaboration with me. The first will appear in these Notes, others will follow in subsequent ones. As absolute rules can hardly be laid down for the reduction of fireball observations, due to their heterogeneous quality, good judgment is specially needed in this field. I should like to take occasion here to express my sincere appreciation for her efficient and intelligent work.

The solution of the 1948 June 7 fireball, visible over the Mississippi Valley from south to north of Memphis, has been held up in hopes of receiving additional reports from north and west of the path. As it appeared during twilight,

at 8:05 P.M., C.S.T., it must have been seen by thousands. Cannot some reader send us additional reports? We also need more data on the brilliant North Carolina fireball of June 26, 9:32 P.M., E.S.T., and of the Maryland-Pennsylvania fireball of August 17, at 10:31 P.M., E.S.T. This last was extremely bright but reports are too few as yet to make it possible to compute heights. With all the publicity that meteoric astronomy has received of late years, unless special requests are placed immediately in the papers, the number of reports that come on even the brightest object are still disheartenningly few.

A résumé of the reports received during late July and through August, which cover the period when the Perseids are supposed to appear, will be given in a later paper when there has been more time for all observations to be received. New supplies of meteor maps and forms are now available here, so requests for them can be promptly filled. In closing, please remember that October is one of our best months for meteors and that work on any clear, moonless night, if carried through several hours, should result in one or more radiants being determined.

Fireball of 1947 December 30

Nancy E. Weber

On this date at 7:30 P.M., P.S.T., a brilliant fireball appeared traveling westward over southern Oregon. The regional director for the northwestern part of the United States, Professor J. Hugh Pruett, gathered numerous reports from observers in Oregon, California, and Nevada, and from these made an approximate solution of the path. He sent both his solution and all the 47 reports to the Flower Observatory where another solution was independently made. Ours agreed closely in all respects with that of Pruett's except for the heights. He has methods by which he reduces the observed altitudes to what he thinks they should be, while we used the data as stated by the observers. Undoubtedly, observers usually overestimate altitudes, so our resulting heights in this case are probability too high. A few estimates, which gave impossibly great heights, were omitted from our solution.

A map, making proper allowance for converging meridians, was constructed and the azimuths plotted. Both the sub-end point and sub-beginning point were quite well fixed. This was due, in part, to the fortunate location of stations with respect to the meteor's path. The altitudes were not so well determined, however. A very serious drawback to the observations was that not one gave the altitude of the fireball with reference to an identifiable celestial body. The terrain in most of this section is mountainous which would make difficult the estimation of angular distances from the true horizon.

The meteor was most generally reported to be bluish-green in color. It appeared to explode twice, lighting up the countryside to close observers. The sound phenomena were limited to 6 out of the 47 observers—three of the six were located in the vicinity of Lakeview, two in Klamath Falls, and one in Portland, all beyond the end point. Different observers estimated its brightness from as low as one tenth that of the Moon to as high as that of the full Moon. The reports of the duration of flight differed from one or two seconds to ten seconds. Because of this discrepancy a solution of the velocity did not seem warranted, and a parabolic velocity was assumed. The data follow:

Date	1947 December 30 7:30 P.M., P.S.T., GMT Dec. 30.31
Sidereal time at end point	31° 18′
Began over	$\lambda = 118°\ 1'$, $\phi = 42°\ 37'$ at 199 ± 23.9 km. (12 obs.)
Ended over	$\lambda = 119°\ 56'$, $\phi = 42°\ 32'$ at 96 ± 29.0 km. (18 obs.)
Length of path	181.3 km.
Projected length of path	153.1 km.
Radiant (uncorrected)	$a = 266.^{\circ}5$ $h = 30.^{\circ}9$
Zenith correction (parabolic velocity assumed)	$-2.^{\circ}2$
Radiant (corrected)	$a = 266.^{\circ}5$, $h = 28.^{\circ}7$; $\alpha = 99.^{\circ}4$, $\delta = 22.^{\circ}7$

(This radiant is A.M.S. No. 2312)

The elements of the resulting parabolic orbit are:

$$i = 0.^{\circ}5,\ \Omega_{\odot} = 98°,\ \pi = 188°,\ q = 0.49 \text{ A.U.}$$

From the height at which the meteor exploded it is doubtful whether any fragments reached the ground.

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1948 September 2.

Contributions of The Meteoritical Society

(Known Formerly as The Society for Research on Meteorites)

Edited by FREDERICK C. LEONARD

Department of Astronomy, University of California, Los Angeles 24

The Furnas County Stone of the Norton County, Kansas-Furnas County, Nebraska, Achondritic Fall (1000,400)*

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ABSTRACT

A preliminary account is given in this paper of a record-breaking meteorite—the Furnas County member of the extraordinary Norton County, Kansas-Furnas County, Nebraska, achondritic fall of 1948 February 18 (coördinate number = 1000,400). This specimen, discovered on 1948 August 16, is conservatively estimated to weigh 1 metric ton (2200 lbs.). If that estimate is correct, or nearly correct, then the Furnas County stone is by far the largest known *aerolite* in the world and the largest meteorite of *any* type ever *observed* to fall. Several other significant facts concerning this remarkable meteorite are noted and briefly discussed. The giant aerolite was recovered thru the combined efforts of the Institute of Meteoritics of the University of New Mexico and the University of Nebraska State Museum, which have acquired joint ownership of it.

The Norton County, Kansas, achondritic fall (1000,400) was announced and briefly described in a note by Dr. Lincoln LaPaz, published in *Science*, **107**, No. 2786, 543, May 21, 1948, and reprinted in *C.M.S., P.A.*, **56**, 391, Aug., 1948. On 1948 July 3, Mr. Arthur E. Hahn of Norton, Kansas, and Mr. O. E. Gill of

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Wilsonville, Nebraska, found a nearly circular hole, about 6 feet in diameter and 6 feet deep, on the Helen Whitney ranch, some ¾ths of a mile north of the Kansas-Nebraska state line. Investigation of that hole, on 1948 August 16, by Mr. Harold R. Hahn (a son of the forenamed Mr. Hahn), assisted by Mr. Dale Stevenson of Norton, Kansas, and Mr. Forrest Warren of Wilsonville, Nebraska, led to the discovery of a huge aerolite, of which the upper surface lay buried at a depth of approximately 1 foot below the bottom of the unexcavated impact hole. This aerolite, a fragile, friable, ferriferous, calcium-poor (enstatite) achondrite (cl. = A_3), is a member of the extraordinary Norton County fall of 1948 February 18, 4:56 P.M., C.S.T., and, to date, is by far the largest known member of that fall.

On August 18, a party from the Institute of Meteoritics of the University of New Mexico, consisting of its Director, Dr. Lincoln LaPaz, his daughter, Miss Jean LaPaz, Mr. and Mrs. Douglas M. Gragg, and me, reached the meteorite *in situ*. Our party was soon joined in the field by one from the University of Nebraska, composed of Dr. C. Bertrand Schultz, Director of the University of Nebraska State Museum, Professor E. F. Schramm, Chairman of the Department of Geology of that University, and Messrs. A. Allen Graffham and Morris E. Mendenhall of the State Museum staff. At 1:30 P.M., on August 25, the meteorite, which, for protection, had been completely incased in a thick plaster-of-Paris coat, was, by means of a crane, removed from its hole and placed upon a truck, for transportation to Albuquerque, New Mexico. After the impact hole was completely excavated, the top and bottom surfaces of the specimen were found to have lain at depths of 7 and 10 feet below the level of the surrounding, undisturbed soil.

At the date of writing (August 27), the integrated weight of the mammoth aerolite and its many detached fragments is not, of course, known, but, on the basis of preliminary measurements and computations made in the field, this appears to be at least 1 metric ton (2200 lbs.)! The meteorite, a beautifully pitted and oriented stone, has the shape of a roughly elliptical conoid, the major and minor axes of the elliptical base of which measure 42 and 39 inches, and the altitude, 36 inches. The stone was embedded in the ground with its "nose" or apex pointing downward. Most of the interior of the specimen is pale bluish-gray or chalky-white, altho bits of the mass are tawny, pinkish, or greenish. Superficially oxidized inclusions of nickel-iron, some of them as large as a marble, are interspersed thruout the interior and are visible occasionally on the surface. The fusion crust varies in color from dead white to jet black, tho much of it is light muddy-gray.

The Furnas County member of what will now have to be called the Norton County, Kansas-Furnas County, Nebraska, fall seems to have broken several very important meteoritical records; if, as is almost certain, its weight considerably exceeds 1250 lbs.—that of the Long Island, Phillips County, Kansas, stone (C.N. = 996,399; cl. = Chy,iv), found in 1891—then it is by far the largest known *aerolite* in the world, and likewise the largest meteorite of *any* type ever *observed* to fall—the next largest meteorite of witnessed fall being the chief Paragould, Green County, Arkansas, aerolite (C.N. = 905,361; cl. = C,g), which fell 1930 February 17, 4:08 A.M., C.S.T., and which weighed about 800 lbs.;[1] moreover, the Furnas County stone is a member of the first fall that, to my knowledge, has crossed a state line (hence the compound name, which must now be given to this fall). Another notable fact about the meteorite is that it belongs to the comparatively rare class of achondrites, which together con-

FIG. 1
THE FURNAS COUNTY ACHONDRITE AT THE BOTTOM OF ITS IMPACT HOLE
Harold R. Hahn Facing the Meteorite
Photograph by Douglas M. Gragg

stitute but 9% of the classified *aerolitic* falls of the world[2] and which have been recovered hitherto in the form usually of only very small masses. In *C.M.S., P.A.*, **56**, 391, Aug., 1948, the statement was made that "altho this fall appears to have covered a considerable area, it may be provisionally assigned the coördinate number 1000,400." The definitive 7-digit coördinate number of the Furnas County stone itself has turned out to be exactly 1000,400—a round and easily remembered number!

With little doubt, this immense aerolite represents the main mass of the remarkable meteoritic shower of 1948 February 18. That the strewn field of that shower was correctly calculated, as long ago as last March, at the Institute of Meteoritics, is evidenced by the positions of the one thousand or more recoveries made up to date, including the next-to-the-largest or 131½-lb. specimen located last May on the McKinley ranch in Norton County, as well as the great Furnas County stone. All of the smaller specimens of the fall, and the major portion of the Furnas County aerolite, are now in the possession of the Institute.

After a 700-mile, 20-hour drive from its place of fall in Furnas County, Nebraska, the huge meteorite, in its plaster incasement, arrived "safe and sound" in Albuquerque at 10:20 o'clock in the evening of August 26, and, early the following afternoon, was "safely stowed" in the Institute of Meteoritics of the University of New Mexico.

The Furnas County stone has been acquired jointly by the Institute of Meteoritics of the University of New Mexico and the University of Nebraska State Museum, the two institutions that were responsible for its recovery. For the present, and at least until the close of the 11th Meeting of The Meteoritical Society—at which the giant achondrite will be placed on public exhibition for the first time—it will remain intact at the Institute of Meteoritics.

NOTE AND REFERENCES

[1] The Furnas County aerolite is in all likelihood the *sixth* weightiest meteorite on record for the entire United States, being exceeded in mass by these 5 individuals, all of which are *siderites:* Willamette, Oregon (1226,454); Alpine, Texas (1030,290:); Navajo, Arizona (1098,365); Quinn Canyon, Nevada (1154,381); and Goose Lake, California (1205,420); *cf.* Miss Alley's and my "Catalog of the Largest Known Meteorites of the World," *C.M.S.*, **4**, 71-5; *P. A.*, **55**, 497-502, 1947.

[2] *Cf.* my "Statistical Studies of the Meteoritic Falls of the World: 4. Their Classificational Distribution," *C.S.R.M.*, **3**, 65-70; *P. A.*, **51**, 44-9, 1943; and "7. Numbers and Percents of Observed and Unobserved Falls of All Classes," *C.S.R.M.*, **3**, 235-9; *P. A.*, **54**, 44-8, 1946.

A Simplified Classification of Meteorites and Its Symbolism*

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ABSTRACT

An attempt is made in this paper to effect a simplification of the classification of meteorites and a revision of the symbols that pertain to it. Meteorites (symbol = Mi) are classified, first, into 3 *divisions:* aerolites (Ae), siderolites (So), and siderites (Si); second, into 7 *classes:* achondrites (A), chrondrites (C), sideraerolites (S), lithosiderites (L), hexahedrites (H), octahedrites (O), and ataxites (D); and third, into 29 separately distinguishable *subclasses,* of which the symbol, in each case, indicates primarily the *class* to which the meteorite belongs. Table 1 is a list of 16 "Qualifying Symbols or Qualifiers"—single, lower-case letters—used in connection with the symbols of the divisions, the classes, and the subclasses—in the last-named case, to form the symbols of *variants* or *secondary subclasses.* Table 2, entitled "Subclasses of Meteorites and their Symbols," gives the names of the subclasses and both their new and their old symbols. Several matters relating to this system of classification are discussed; the classificational sequence of meteorites, in terms of the 7 classes of meteorites, is reviewed in the light of it; and, finally, 3 recommendations are made concerning the system and its application to future studies of meteorites and meteoritic falls—in particular, statistical studies of the latter.

The classification of meteorites is notoriously in need of simplification, and its symbolism is just as flagrantly in need of revision. An attempt is made in this paper to effect a simplification of the classification and a revision of the symbols that pertain to it. G. T. Prior vastly improved and simplified the cumbersome Rose-Tschermak-Brezina system,[1] in a modification published in 1920,[2] but he did almost nothing with the symbolism. In general conformity with Prior's modification, however, additional changes are here introduced, for the

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purpose, not only of further simplifying and abbreviating the classification, but also of rationalizing and regularizing the symbols that relate to it.

First, meteorites (symbol = Mi) shall be partitioned into those 3 universally recognized *divisions* known as aerolites (Ae), siderolites (So), and siderites (Si).[3] Second, these 3 divisions shall be resolved into 7 principal *classes*, of which each shall be represented by a symbol consisting of a single capital letter, thus:

Aerolites (Ae)	{ Achondrites (A) { Chondrites (C)
Siderolites (So)	{ Sideraerolites (S) { Lithosiderites (L)
Siderites (Si)	{ Hexahedrites (H) { Octahedrites (O) { Ataxites (D)

These 7 classes are the analogues, in meteoritics, of the Harvard classes of stellar spectra in astronomy; for, just as every sidereal spectrum can be classified normally under one of the Harvard spectral classes, so every recognized meteorite can be classified usually under one of the forenamed meteoritic classes.

It is proposed that the capital-letter symbol of the meteoritic class shall constitute an integral part of the symbol of each of the *subclasses* thereunder, so that the *class* to which any meteorite belongs shall be evident by mere inspection of the subclassificational symbol of the meteorite: that this is *not* true of the large majority of the symbols employed in the Rose-Tschermak-Brezina system is obvious. It is proposed further that as many of the following (*v.* Table 1) *qualifying symbols* or *qualifiers—i.e.*, single, lower-case letters—as may be required shall be suffixed to the symbol of the division, the class, or the subclass, from which the qualifier or qualifiers shall be separated by a *comma*.

TABLE 1. QUALIFYING SYMBOLS OR QUALIFIERS

a—grained or granular	n—having (or with) silicate inclusions
b—brecciated	o—oxidized
c—spherical or spherulitic	p—peculiar or atypical
e—fused	r—carbonaceous
f—friable	s—black
g—gray	t—vitreous
i—intermediate	v—veined
k—crystalline	w—white

All but 2 of these qualifying symbols (*i.e.*, "r" for "carbonaceous" and "v" for "veined") are the same as their counterparts in the Rose-Tschermak-Brezina system; several new ones have, however, been added. The qualifiers "a" for "grained" or "granular," "e" for "fused," and "n" for "having (or with) silicate inclusions" should be applied only to siderites (Si), including lithosiderites (L), whereas the remaining ones should be applied only to aerolites (Ae), including sideraerolites (S)—except "o" for "oxidized" and "p" for "peculiar" or "atypical," which may be applied to both types of meteorites. The qualifier "a" for "grained" or "granular," instead of "b" for "brecciated," should be used henceforth for all those hexahedrites (H) and octahedrites (O) that have hitherto been inaptly described as "brecciated."[4]

In Table 2 are listed, alphabetically in the second column, all the *subclasses* of meteorites that, it is believed, are at present demanded for the purposes of classification. These subclasses, when followed by the necessary qualifiers in Table 1, should suffice for the most detailed classification of all the diverse kinds

of meteorites known today. In the first column of Table 2 is given the proposed new symbol of the subclass, and, in the third column, the old symbol (usually, tho not always, the symbol in the Rose-Tschermak-Brezina system).

TABLE 2. SUBCLASSES OF METEORITES AND THEIR SYMBOLS

NEW SYMBOL	SUBCLASS	OLD SYMBOL
A_2	Achondrite, calcium-poor	Ac_2
A_1	Achondrite, calcium-rich	Ac_1
A_2am	Amphoterite (1)	Am
A_1an	Angrite§ (2)	A or An
Do	Ataxite, intermediate (3) (called also Metabolite)	D_3
D_{II}	Ataxite, nickel-poor (4)	D_2
D_1	Ataxite, nickel-rich (5)	D_1
A_2au	Aubrite* (6)	Au
A_2bu	Bustite* (6)	Bu
A_2ch	Chassignite (7)	Cha
A_2cl	Chladnite† (8)	Chl
Cbr	Chondrite, bronzite-olivine (9)	Cbr
Cen, k	Chondrite, enstatite-anorthite, crystalline (10)	Cek or Cen
Cho	Chondrite, howarditic (11)	Cho
Chy	Chondrite, hypersthene-olivine (12)	Chy
(A_2+C)cu	Cumberlandite (13) (called also Whitleyite)	Cu
A_2di	Diogenite† (8)	Di or Dio
A_1eu	Eukrite (14)	Eu
Smg	Grahamite: *v.* Mesosiderite, grahamite‡ (17)	Mg or Msg
A_1ho	Howardite (15)	Ho
Slo	Lodranite (16)	Lo
Sms	Mesosiderite‡ (17)	M or Ms
Smg	Mesosiderite, grahamite‡ (17)	Mg or Msg
Do	Metabolite: *v.* Ataxite, intermediate (3)	D_3
A_1na	Nakhlite§ (2)	Na or Nk
C, chf	Ngawite‖	Ccn
Og	Octahedrite, coarse (18)	Og
Ogg	Octahedrite, coarsest (19)	Ogg
Of	Octahedrite, fine (20)	Of
Off	Octahedrite, finest (21)	Off
Om	Octahedrite, medium (22)	Om
C, cf (Orn.)	Ornansite‖	Cco
C, s (Orv.)	Orvinite‖	Co
Lpa	Pallasite	P
—	Pallasite, Albacher group: *v.* Pallasite, Bitburg group (23)	Pa
Lpa (Bit.)	Pallasite, Bitburg group (23) (called also Albacher group)	Pb or PB
Lpa (Imi.)	Pallasite, Imilac group (24)	Pi or PI
Lpa (Kra.)	Pallasite, Krasnojarsk group (25)	Pk or PK
Lpa (Rok.)	Pallasite, Rokicky group (26)	Pr or PR
A_2am, b	Rodite‖	Ro
A_1sh	Sherghottite (27)	She
Lsy	Siderophyre (28)	Si or Sy
C, s (Tad.)	Tadjerite‖	Ct
A_2ur	Ureilite (29)	U or Ur
(A_2+C)cu	Whitleyite: *v.* Cumberlandite (13)	Wht

NOTES TO TABLE 2

*Aubrite (A_2au) is practically the same as bustite (A_2bu) in the Rose-Tschermak-Brezina classification.

†Diogenite (A_2di) corresponds most closely to chladnite (A_2cl) in the Rose-Tschermak-Brezina classification.

‡According to G. T. Prior (*Min. Mag.*, **19**, 59, footnote (2), 1920), "Under [the name mesosiderite] are included both the groups mesosiderite and grahamite of the Brezina classification, since, as shown by the writer (*Min. Mag.*, **18**, 151-72, 1918), no distinction can be drawn between the two as regards the amount of felspar."

§Nakhlite (A_1na) is not distinguished from angrite (A_1an) in the Rose-Tschermak-Brezina classification.

‖Ngawite (C, cbf), ornansite (C, cf (Orn.)), orvinite (C, s (Orv.)), rodite (A_2am, b), and tadjerite (C, s (Tad.)) are *secondary*, rather than *primary*, subclasses; that is, they are *variants* of the latter, as is evident from the classificational symbol of each, which consists of the symbol of a class or a subclass, followed by one or more qualifiers (*cf.* Table 1, *ante*); *e.g.*, ngawite (C, cbf) is merely a friable, brecciated, spherical (or spherulitic) chondrite, and orvinite (C, s (Orv.)) is only a variety of black chondrite, whereas rodite (A_2am, b) is simply a brecciated amphoterite. Probably all 5 of the foregoing terms—in company with a number of others—should be dropped from the classification of meteorites.

As is evident from the notes to Table 2, 4 of these subclasses, namely, aubrite (A_2au), diogenite (A_2di), grahamite (Smg), and nakhlite (A_1na), are practically identical with bustite (A_2bu), chladnite (A_2cl), mesosiderite (Sms), and angrite (A_1an), respectively; whereas ngawite (C, cbf), ornansite (C, cf (Orn.)), orvinite (C, s (Orv.)), rodite (A_2am, b), and tadjerite (C, s (Tad.)) are in reality but *secondary* (*i.e.*, further qualified or classified) *subclasses;* hence the total number of differentiable subclasses (*i.e.*, those whose names are followed in the table by parenthesized numbers), exclusive of calcium-poor achondrite (A_2), calcium-rich achondrite (A_1), and pallasite (Lpa) (not further classified or subdivided), is 29—less than 40% of the number (76) separately enumerated, *e.g.*, on pp. 198-203 of Farrington's *Meteorites*.[5]

The symbol D_O for intermediate ataxite (more rarely and less appropriately termed "metabolite") and the symbol D_H for nickel-poor ataxite are proposed to replace the old symbols D_3 and D_2, respectively, because of the probable genetic relationship of these 2 varieties of ataxites to octahedrites (O) and hexahedrites (H), respectively, the intermediate ataxites (D_O) being doubtless nothing other than octahedrites (O) that have been transformed into ataxites (D) by pre-terrestrial heating, and the nickel-poor ataxites (D_H) being hexahedrites (H) that have been similarly transformed. The nickel-poor ataxites (D_H) have, of course, practically the same nickel content as the hexahedrites (H), whereas the intermediate ataxites (D_O) may—and doubtless do—have precisely the same *range* of nickel content as the octahedrites (O): hence the choice of the symbols D_H and D_O for these subclasses. The old symbol D_1 is retained, however, for the nickel-rich ataxites, which are the only sort of ataxite presenting "a primary structure," the other 2 kinds, as just remarked, being "product[s] of alteration by reheating."[6]

The compound symbol ($A_2 + C$)cu is used for cumberlandite (called also, less happily, "whitleyite") to indicate that this subclass of meteorite—which has been described as "a breccia consisting of fragments of white aubrite (enstatite achondrite) and black enstatite chondrite"—is a "composite," of which the 2 components are aubrite (A_2au) and enstatite chondrite (Cen).

Both the so-called breccia-like (*i.e.*, granular) octahedrites of the Netschaëvo, Kodaikanal, Copiapo, Zacatecas, and Zacatecas-N'Goureyma (or N'Goureyma) groups (Nos. 61-5 in the list in Farrington's *Meteorites*, pp. 202-3), and the octahedrites of the so-named Hammond group (not mentioned in that list), are missing from Table 2. The reason is that every octahedrite, regardless of what-

ever individual peculiarities it may possess, is classifiable as essentially a coarsest, coarse, medium, fine, or finest octahedrite (Ogg, Og, Om, Of, or Off). These 6 groups are, then, but variants of the 5 subclasses of octahedrites, and all the members of these groups should be reclassified in accordance with the system of Tables 1 and 2.

None of the 8 groups of nickel-rich and nickel-poor ataxites (*viz.*, the Cape, Shingle Springs, Babb's Mill, Linville, Nedagolla, Siratik, La Primitiva (or Primitiva), and Tucson (or Muchachos) groups, Nos. 69-76 in Farrington's list, *op. cit.*, p. 203) appears in Table 2. The authority for this omission is the following self-explanatory statement excerpted from p. 7 of Perry's "The Metallography of Meteor[it]ic Iron":[7] "Ataxites were classified by the older writers into numerous subgroups, including [those just enumerated]. These designations or symbols appear in many museum labels and catalogs. Such classification, however, was based upon superficial characteristics and has little meaning from the standpoint of metallography. In the writer's opinion, only 2 classes need be recognized, nickel-poor and nickel-rich ataxites" (D_H and D_L, respectively, in the present symbolism).

All the 4 groups of pallasites (namely, Bitburg (or Albacher), Imilac, Krasnojarsk, and Rokicky) have been retained in Table 2 as *possibly* distinct subclasses, pending further investigation, which may—and probably will—show that even these 4 subclasses are too many.

One of the principal aims in the development of this classification has been to eliminate as many of the "proper-name" groups as possible, the result being that well-nigh the only ones left are the 4 groups of pallasites.[8] Most groups have proved upon examination to be merely variants of certain subclasses, and to be readily classifiable thereunder, by aid of the proper qualifiers in Table 1.[9]

The classificational sequence of meteorites[10] will now be briefly reviewed in the light of the present system of classification. With reference only to the 7 *classes* of meteorites, that sequence may be re-written thus:

$$\left.\begin{matrix} A_1 - A_2 \\ | \\ C \end{matrix}\right\} - \{S - L\} - \{H - O - D_L\}.^{11}$$
$$\qquad\qquad\qquad\qquad\qquad\quad | \quad |$$
$$\qquad\qquad\qquad\qquad\qquad\quad D_H \quad D_O$$

That this is fundamentally a specific-gravity sequence,[12] with the specific gravity increasing from left to right, as the sequence is arranged, is obvious.

In conclusion, I desire to make 3 recommendations: (1) that meteorites be classified henceforth in accordance with the present system of classification, which includes 3 divisions, 7 classes, and 29 subclasses, any one of which may, if necessary, be modified by the use of the appropriate qualifiers in Table 1;[13] (2) that in studies of meteorites and meteoritic falls—particularly, statistical studies of the latter—this system be employed; and (3) that special attention be paid in those studies to such important matters as the *order* and *interrelationships* of the various meteoritic subclasses—matters that are considered in some detail in my paper on the classificational sequence of meteorites.[10]

References and Notes

[1] *V., e.g.*, O. C. Farrington's *Meteorites*, Ch. 12, "Classification of Meteorites," 197-204, 1915.

[2] *V.* G. T. Prior, "The Classification of Meteorites," *Min. Mag.*, **19**, 51-63, 1920, and also the "Introduction" to his *Catalogue of Meteorites . . . British Museum (Natural History)*, vi-viii, 1923.

[3] If tektites prove to be meteorites, they shall be regarded as constituting the *fourth division* of those bodies (*i.e.*, the division of *all-glass* meteorites), for which the 2-letter symbol "Te" shall be reserved.

[4] *Cf.* Stuart H. Perry's "The Metallography of Meteor[it]ic Iron," *U. S. Nat. Mus. Bull. 184*, 52 and 63, 1944.

[5] This number (29) checks very closely with the number of subclasses retained in Prior's classification, *loc. cit.*, ref. ([2]), *ante*.

[6] Perry, *op. cit.*, ref. ([4]), *ante*, 69.

[7] *U. S. Nat. Mus. Bull. 184*, 1944.

[8] *Cf.* n. (‖) to Table 2, *ante*.

[9] *E.g.*, "fine octahedrite, Victoria group" (No. 53 in Farrington's list, *op. cit.*, ref. ([1]), *ante*, 202), has been excluded from the classification as a primary subclass, because it is evidently nothing but a special case of—*i.e.*, a *secondary subclass* under—fine octahedrite (Of).

[10] *V.* Frederick C. Leonard, "A Classificational Sequence of Meteorites," *C.M.S., P. A.*, **56**, 41-6, Jan., 1948.

[11] By means of the device in the paper just cited (ref. ([10]), *ante*), and Table 2, *ante*, the sequence may be written out in full, almost as readily, with the symbols of all the 29 *subclasses* of meteorites recognized in the present system.

[12] Just as the Harvard spectral sequence is primarily a temperature, and secondarily an ionization, sequence.

[13] Whenever possible, the subclass (qualified or unqualified), to which a meteorite belongs, should be given, and, in every case, the class. If a specimen is known to be a meteorite, the division that it represents must be nearly as apparent as its cosmic character; the class, which constitutes the very essence of the classification, lies just one step beyond the division, a step that the professional meteoriticist, certainly, has little if any excuse for not taking in the work of appraising a meteorite. The practice of announcing new falls merely as "stones" or "irons," or even as aerolites, siderolites, or siderites, cannot be defended as good meteoritical procedure; the class, at least, should always be determined and made known.

A Request for Information concerning Newly Reported Meteoritic Falls*

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ABSTRACT

The coöperation of all persons concerned, in supplying 7 essential items of information regarding newly reported meteoritic falls, is solicited, for the reasons stated.

An attempt is being made to bring our manuscript (card) catalog of the meteoritic falls of the world up to date. With that end in view, a request is hereby issued to all persons concerned, that as many as possible of the following 7 items of information regarding each newly reported fall—observed or unobserved—be promptly communicated to us. These items—and several others—are discussed in detail in a paper entitled "Desiderata for a General or Comprehensive Catalog of the Meteoritic Falls of the World,"[1] to which the reader is referred for further particulars. The most essential items of information relating to each new fall are the following: (1) the geographical coördinates of the place of fall or find, from which the coördinate number (C.N.) may be derived; (2) the full geographical name; (3) the class; (4) the date and the *standard* time (A.M. or P.M.) of the occurrence of an observed fall; or the date

*Read at the 11th Meeting of the Society, Albuquerque, New Mexico, 1948 Sept. 7-8.

of the discovery of an unobserved fall; (5) the total or integrated weight, in *grams* or *kilograms*, of all the recovered specimens; (6) the number *&c.* of all the known complete-individual masses, and the weights of the largest ones; and (7) the principal depository or depositories where the material is preserved.

The *longitude* and the *latitude* of the place of fall or find should be recorded to at least the nearest tenth of a degree (0°.1), so that a definitive 7-digit coördinate number can be assigned to the fall; still better, if the coördinates have been determined to the closest half-minute of arc (0°.5), a 9-digit number can be assigned to it.[2]

The *class* of the fall should always be listed, as accurately as this can be ascertained. We urge that falls be classified by their reporters not merely as "irons" or "stones," or even as siderites (divisional symbol = Si), siderolites (So), or aerolites (Ae), but, *whenever possible*—and if not *more* precisely—as achondrites (class symbol = A), chondrites (C), sideraerolites (S), lithosiderites (L), hexahedrites (H), octahedrites (O), or ataxites (D).†

We plan henceforth to announce new falls serially in *C.M.S.*, and to give as many of the 7 forenamed items concerning each newly reported fall as may be available at the time of the current announcement.[3] We propose likewise to issue, in the not-too-distant future, a supplement to our "Catalog of Provisional Coördinate Numbers for the Meteoritic Falls of the World,"[4] and eventually to publish the more comprehensive manuscript catalog.

References and Notes

[1] *C.S.R.M.*, **3**, 301-4; *P. A.*, **54**, 544-7, 1946.

[2] *Cf.* my paper on "A General Definition of the Coördinate Number of a Meteoritic Fall," *C.M.S.*, **4**, 82-4; *P. A.*, **55**, 553-5, 1947; in particular, note [3].

[3] Which will include also a reference to the original announcement, if that was published elsewhere.

[4] *Univ. of New Mexico Publ. in Meteoritics*, No. 1, 1946; this catalog gives the 7-digit coördinate number, the full geographical name, and the class of every fall contained in it.

†*Cf.* the immediately preceding paper on "A Simplified Classification of Meteorites and its Symbolism."

1948 August 11

President of the Society: Arthur S. King, 925 Topeka Street, Pasadena 6, California

Secretary of the Society: Oscar E. Monnig, 1010 Morningside Drive, Fort Worth 3, Texas

VARIABLE STARS

Variable Star Notes from the American Association of Variable Star Observers

By LEON CAMPBELL, Recorder

Bright Maximum of RR Telescopii: Mr. P. Kirchhoff of Johannesburg, South Africa, calls attention to the exceptionally bright maximum of RR Telescopii, 1956*b*, during the present season. Originally discovered photographically at Harvard, it was at first thought to be of the SS Cygni type. Subsequently it was suggested that it was a long-period variable with a period around 384 days.

Still later observations made by the Milton Bureau showed that the star is of a very peculiar type, probably semi-regular rather than long-period. Seven published dates of maxima appear to satisfy the period of $386^{d}.73$, excepting that of May, 1935. With a period so nearly that of a year, it may be that the true period is some multiple of 386 days. The observed photographic maximum is below magnitude 12.5, quite in contrast to the visual brightness of 6.5 reported at the 1948 maximum. The star surely deserves the closest attention.

Notes on Special Variables: S Cassiopeiae, 011272, one of the long term long-period variables, 20 months, attained maximum, magnitude 9.0, late in June and is now gradually decreasing in light to minimum.

UV Persei, 020356, one of the SS Cygni-type variables, was at maximum early in August, magnitude 12.5.

o Ceti, 021403, increased in brightness from magnitude 9.0 on July 1, to 4.0 on September 6. It attained magnitude 6.0 on August 7, 340 days after reaching the same magnitude on the increasing side of the curve of the 1947 maximum. This fact should indicate a not too bright maximum for this season.

R Doradus, 043562, for the past 700 days has varied between magnitude 5.2 and 6.5 in a somewhat irregular manner.

RU Puppis, 080322, an N-type variable, has over the past 700 days varied between magnitudes 7.9 and 9.0 in an irregular manner.

Z Camelopardalis, 081473, during the past six months hovered around magnitude 11.5 to 12.0, instead of varying through its usual range from 10.5 to 13.2 in a rough period of 11 to 35 days.

RR Carinae, 095458, although not presenting a too regular form of light curve has recently shown a periodicity approximating 150 days, with a range between magnitudes 7.1 and 8.3.

RS Carinae, 110361, the nova of 1895, is being reported as invisible, fainter than 13.0, and, unless one expects to see it suddenly increase in brightness, it is hardly worthwhile to observe it frequently. The nova originally reached the seventh magnitude and was detected on Harvard plates from the appearance of its spectrum.

R Centauri, 140959, one of the two well-known long-period variables with a double maximum and a shallow secondary minimum, has just passed its first maximum, and should be carefully observed to note accurately the depth of the secondary minimum and height of the second maximum. The shallow minimum should be reached late in December.

S Apodis, 145971, is slowly increasing in light—from below the 14th magnitude to magnitude 12.9 late in July. It had been at minimum from January, 1947, to May of this year.

Nova Serpentis, 154114, appears not to have decreased to a marked extent since observations were begun early in May. Photographic magnitude in February was about 8.0, whereas in May the visual magnitude was about 9.0, with a very small color index. By mid-August the nova was reported at visual magnitude 9.5, indicating a long, drawn-out period of little activity. What course the nova went through between the time of outburst, probably late in 1947 when the region was unfavorably placed for observation, and February, 1948, cannot now be told. If the form of the light curve as observed since May is any criterion, the nova may have behaved as did Nova Herculis in 1936, and is now slowly fading away to its pre-outburst stage, probably a long time hence.

RY Sagittarii, 191033, is now back at normal maximum brightness, after having spent some 300 days at minimum, magnitude 13.4.

R Cygni, 193449, had a bright maximum early in March, magnitude 6.7, as against a magnitude of 9.0 for the early 1947 maximum. Whereas the recent maximum was narrow, the previous one was flat.

Chi Cygni, 194632, appears to have attained magnitude 4.5 at its July, 1948, maximum, a magnitude brighter than that recorded late in 1946.

SS Cygni, 213843, has, after a 50-day period of anomalous activity following maximum number 365, settled down to normal conditions, having been at minimum magnitude 11.9 for 40 days.

Observations received during July and August: A total of 8,659 observations —3,346 in July and 5,313 in August—was contributed by 91 observers as follows:

	July—1948—August					July—1948—August			
Observer	No. Var.	No. Ests.	No. Var.	No. Ests.	Observer	No. Var.	No. Ests.	No. Var.	No. Ests.
Ahnert	..	..	41	281	Kitley	28	121	17	29
Albrecht	..	..	21	24	de Kock	111	273	102	420
Ancarani	19	35	25	46	Koons	..	..	34	36
Ball	..	..	10	10	Ledbetter	..	..	6	9
Bicknell	10	80	..	..	Lee	..	..	29	65
Blunck	17	20	19	28	LeVaux	47	52	15	15
Bogard	32	81	43	79	Luft	5	5	..	..
Bonelli	..	..	1	1	Miller	24	41	26	26
Boone	..	..	8	8	Mussett	5	9	13	23
Buckstaff	14	34	11	38	Nadeau	35	36	22	23
Cain	10	15	17	25	Oravec	43	95	44	159
Chandra	..	..	51	90	Paletsakis	6	101	10	60
Chassapis	104	325	124	800	Parker	26	26	25	25
Contes	5	10	2	4	Parks	22	22	20	30
Cragg	106	106	135	149	Pearcy	49	55	98	104
Dafter	7	35	7	17	Peltier	166	242	186	312
Daley	5	13	6	38	Penhallow	12	22	22	40
Darling	..	..	2	7	Pierson	14	24	20	32
Darnell	..	..	1	2	Plakidis	7	33	4	8
Elias	12	24	38	67	Plybon	6	17	10	10
Dillon	5	10	7	14	Rakosi	6	16	8	14
Edelenyi	3	3	..	..	Reeves	..	..	1	1
Erickson	..	..	27	49	Renner	99	99	138	138
Escalante	15	15	10	11	Rich	5	8	8	18
Estremadoyro	1	1	8	8	Rosebrugh	17	109	17	127
Fernald	228	466	246	730	Rosenvinge	22	49	..	..
Focas	4	4	23	30	Ruiz	2	3	10	21
Flower	..	..	4	13	Schoenke	..	..	11	13
Ford	..	..	22	22	Seagroves	..	..	7	7
Garneau	..	..	10	10	Segers	..	..	21	57
Gergely	3	3	..	..	Slemaker	..	..	13	13
Gingerich	10	19	19	35	Stein	2	7	..	..
Gomi	..	..	2	10	Svolopoulos	..	..	10	10
Greenley	..	..	42	113	Szabadosi	3	7	..	..
Halbach	..	..	35	37	Taboada	39	45	18	18
Hamilton	..	..	5	5	Tarbell	6	10	9	22
Hartmann	97	105	109	126	Thomas	16	16	..	..
Hiett	11	16	..	..	Tifft	13	17	55	100
Holloway	6	8	15	28	Upjohn	9	9	32	51
Howarth	16	22	..	..	Venter	10	17	12	24
Hurukawa	..	..	4	23	Waldmann	7	15	16	35
Kelly	16	16	12	12	Waters	2	5	5	14
Kirchhoff	40	241	36	68	Webb	20	20	14	14

Observer	July—1948—August No. Var.	No. Ests.	No. Var.	No. Ests.	Observer	July—1948—August No. Var.	No. Ests.	No. Var.	No. Ests.
Weitzenhoffer	5	10	..	..	Werntz	..	..	11	20
Welker	..	..	29	49	Yamada	..	..	25	57
Wells	3	3	6	6					
					91 totals	3,346		5,313	

September 15, 1948.

Comet Notes

By G. VAN BIESBROECK

In the course of the two last months three new comets have been announced.

COMET 1948 *h* was discovered on July 15 by C. A. Wirtanen at the Lick Observatory. It was found as a diffuse trail on a plate exposed for two hours with 20-inch astrograph. The comet had the appearance of a round coma centrally condensed of magnitude 15. The discovery position located the comet in Equuleus and gave the motion as slow south-westerly. From measures covering a four-day interval L. E. Cunningham has deduced the following preliminary orbit:

Perihelion passage	1949 April 30.659 U. T.	
Perihelion distance	2.6209 astr. units.	
Longitude of node	119°.534	1948.0
Perihelion to node	227.059	
Inclination	130.877	

It shows that this distant object will remain under observation for a long time and slowly gain in brightness as it approaches perihelion next spring. However, it will then be visible only in the southern hemisphere and hardly come in reach of small instruments.

COMET 1948 *i* was discovered by J. Ashbrook, Yale astronomer, while in residence at the Lowell Observatory, Flagstaff (Ariz.). The telegraphic announcement gave the following information:

1948 August 26.25917 U. T.
Right ascension $23^h\,11^m.9$
Declination $-14°\,50'$
Daily motion -49^s
Daily motion $+\ 2'$
Magnitude 12
Diffuse coma with nucleus
Tail less than one degree long.

Figure 1 herewith shows the appearance of the comet from a plate taken by the writer with the 82-inch reflector of the McDonald Observatory on September 2. There are three exposures on the plate: the longest (6 min.) shows the shape of the broad tail which extends to 10′ from the nucleus; the next one (1 min.) shows best the skew appearance of the inner coma while the third (20 sec.) records only the nucleus which is required for measuring the position. The total brightness was 11th magnitude on that date. No ephemeris is yet available here. There is an indication of speeding up of the motion which makes it probable that the comet is approaching, but not until an orbit has been established can anything be ascertained in regard to the future course of this object. It now moves across the constellation of Aquarius.

FIGURE 1
COMET 1948 *i* (ASHBROOK)

COMET 1948 *j* has just been announced by the Johannesburg Observatory in South Africa as being discovered on September 1 by Johnson. The telegraphic announcement transmitted on September 8 through the Harvard College Observatory gives the following details:

1948 September 1 at $20^h 21^m1$ U. T.
Right ascension $23^h 40^m8$
Declination $-35° 57'$
Daily motion -24^s
Daily motion $-10'$
Magnitude 13
Diffuse coma with condensation.

Nothing further has become known about this object so far. It is located too near the horizon for most northern observatories.

Aside from these new objects a large number of previously announced comets can still be reached but they are all faint, the brightest one being of 12th magnitude on September 2. This is COMET 1948 *d* (PAJDUSAKOVA-MRKOS) the circumpolar object that has been followed since last march.

COMET 1948 *g* (HONDA-BERNASCONI) which was described on p. 396 has faded much more rapidly than expected. On August 11 and September 3 the magnitudes computed in inverse proportion of the 6th power of the distance from the sun were 12.4 and 14.4, respectively. The actual magnitudes recorded here on those dates were 16 and 20! The visibility thus hardly covers a period of three months although the location was most favorable.

McDonald Observatory, Mt. Locke, Fort Davis, Texas, Sept. 11, 1948.

General Notes

Dr. Maud W. Makemson, Director of the Vassar College Observatory, Poughkeepsie, N. Y., has been granted a fellowship for the academic year 1948-9 to pursue her research in Mayan astronomy. She plans to do much of the work at the University of Florida, Gainesville, Fla. John W. Streeter has been appointed to the Vassar faculty and will be in charge during Professor Makemson's absence.

Robert W. Mouser and Jack Eugene Forbes, amateur astronomers of Indianapolis, will be the co-speakers at the meeting of the Indiana Astronomical Society, October 3, at 2:15 P.M., at the Central Library Building. Their subject will be "Star Names and Their Meanings" and will concern recent research they have been doing in this field. Further information may be obtained through the local president, Mr. Emsley W. Johnson, 808 Peoples Bank Building, Indianapolis.

Professor Charles H. Smiley of Ladd Observatory, Brown University, presented to President MacCracken of the Kosciuszko Foundation, New York City, a twenty-inch primary mirror and two secondary mirrors at a meeting of the Foundation on September 17. These three mirrors, which are the optical parts for a twenty-inch reflecting telescope, will be shipped to the Observatory at the University of Cracow in Poland. The gift of American amateur astronomers and Polish Americans, it constitutes a small payment on the huge debt which science and the world owes to Poland for the contributions that Copernicus made in the field of astronomy. The optical parts were made at the Laboratory Optical Co. under the direction of Mr. Stanley Brower, who formerly was an amateur telescope maker.

In his presentation speech, Professor Smiley mentioned some of the work that has been done by the National Books-for-Poland Committee of the Kosciuszko Foundation of which he is secretary. Over 50,000 scientific books have been sent to Poland in the past two years to help refurbish the war-torn libraries of the Polish universities. He emphasized, however, that although this figure is impressive, the surface has scarcely been scratched, and the task which lies ahead is still an immense one.

Astronomy Charted

The above is the title given to a set of twenty-five letter-sized sheets bearing diagrams and descriptive material of various phases of astronomy. The author, Mr. Ralph A. Wright, 4 Mason Street, Worcester, Massachusetts, was led to develop this set because of a desire to make the items clearer to his friends and to furnish other amateur astronomers with material which they might feel the need of.

The charts, with one exception, have been taken from various sources, changed somewhat in some instances to adapt them the better to the purpose in hand. The author supplied the text.

A beginner by a thorough understanding of the charts and a careful perusal of the descriptions of them would acquire a thorough course in elementary astronomy.

Exhibits at the Library of Congress

In recognition of the centennial of the American Association for the advancement of Science, five special exhibits have been arranged at the Library of Congress for September and October. The exhibits are:

1. The first mathematical book, Hodder's Arithmetic (1719), published in the Western Hemisphere, and other rare editions and manuscripts of scientific interest.

2. A letter from Thomas Jefferson to the American Philosophical Society dated January 28, 1797, paying tribute to Benjamin Franklin. Also letters and papers by American Scientists, such as Edison, Agassiz, Fitch, Fulton, Maury, Morse, Newcomb, Thornton.

3. Photographs and publications of American Nobel prize-winners in the field of science. Also the original prospectus and proposed constitution of the A.A.A.S. printed and circulated 100 years ago.

4. A manuscript of "The Theory of Relativity" by Albert Einstein, a copy the author made in November, 1943, of the original manuscript which has been destroyed by fire.

5. A scientific display of geological maps, including examples illustrating their development during the last century.

The Day-Time Meteor Streams, 1948

Dr. Lovell sends the following note from the Jodrell Bank Experimental Station of the University of Manchester, on some recent results of the radio-echo work on meteors.

The extensive daylight meteor activity found during the spring and summer of 1947 (*Circulars* Nos. 282, 285; *The Observatory*, **68**, 49, 1947) has re-appeared this spring. The principal phenomena observed so far (May 31st) bear a very close resemblance to those of 1947. The η-Aquarid stream was again followed by a belt of activity lying in the ecliptic and extending from Aquarius through Pisces. As before the most persistent radiant was in Pisces. It appeared on April 30th at $\alpha = 23°$, $\delta = +20°$ and lasted until May 25th when it was at $\alpha = 45°$, $\delta = +20°$. Marked radiants preceding and following were again in evidence.

The sudden appearance of even more active radiants near the Pleiades on May 28th was a very striking phenomenon. The information obtained in 1947 was that a radiant appeared at $\alpha = 45°$ to $55°$; $\delta = +25°$ to $+35°$ on this date. Improved technique has shown that this can be resolved into two marked centres at $\alpha = 50°$, $\delta = +27°$ and $\alpha = 65°$, $\delta = +33°$.

The additional evidence accumulated this year indicates that the belt of activity appearing from Aquarius and Pisces definitely ends between May 24th and 27th but is followed immediately by the new showers near the Pleiades at higher declination.—*British Astronomical Association Circular*, No. 297.

The information already given in *Circular* No. 297 indicated that the day-time meteor activity during 1948 May closely resembled the phenomena found in 1947 (*M.N.*, **107**, 369, 1947). The activity in 1948 June was also closely related. The radiants near the Pleiades disappeared in mid-June and were followed by the very active radiants near β Tauri and 54-Persei as in 1947 (Streams G and F in the *M.N.* paper). In 1947 the observations were insufficient to delineate the radiants during July, but in 1948 the work has been continued in detail, yielding the following information.

The radiants in Taurus and Perseus continued until July 10. July 11 was a day of very confused activity, but on July 12 three new streams appeared suddenly:—

$\alpha = 90°, \delta = +18°$ near χ Tauri, with hourly rate = 30
$\alpha = 100°, \delta = +20°$ near γ Gemini, with hourly rate = 40
$\alpha = 122°, \delta = +13°$ near β Cancri, with hourly rate = 20

The radiant in Cancer became very feeble after a few days, but the radiants in Taurus and Gemini were mainly responsible for the day-time activity until July 18. On this date the activity became fairly uniformly scattered between $\alpha = 75°$ and $\alpha = 150°$ and no marked radiants were in evidence. This situation has continued until the end of July, but on July 19 marked radiants appeared in the region of $\alpha = 55°$ to $75°$, $\delta = +20°$ and concentrated activity in this region has continued until the time of writing (July 30).

In the last week of July the rate of meteoric activity at night became comparable with the day-time rate for the first time during the summer months. For example, in the 24 hours 1948 July $28^d\ 08^h\ 30^m$ to 1948 July $29^d\ 08^h\ 30^m$, the number of meteors recorded during the hours of darkness (July $28^d\ 21^h\ 30^m$ to July $29^d\ 03^h\ 00^m$) was 43, giving a mean rate of 7.8 per hour. These were mainly from the known radiants near α Capricorni, α Cygni, and δ Aquarii. During the daylight hours in this period 147 meteors were recorded giving a mean rate of 7.9 per hour—90 of these were recorded between 1948 July $28^d\ 08^h\ 30^m$ and $15^h\ 00^m$ giving a mean rate over this period of 13.9.

The velocities of many of the day-time meteors have been measured by Ellyett and Davies (*Nature*, **161**, 596, 1948, gives a description of the method). Although the analysis is incomplete all velocities so far obtained show that the orbits of these meteor streams are elliptical. *British Astronomical Association Circular*, No. 300.

Palomar Mountain Observatory Commemorative Postage Stamp Inaugurated

As planned, the postage stamp commemorating the opening of the Palomar Mountain Observatory was placed on sale on Palomar Mountain on August 30 with appropriate ceremonies. The Honorable Samuel R. Young, executive assistant to the Postmaster General, spoke in part as follows:

"We are gathered here on this famous mountain top, in the great Palomar Mountain Observatory, for the purpose of properly marking the occasion of the first-day sale of the new postage stamp commemorating the Observatory and honoring astronomers.

"There is always great national interest and significance in the first offering of a new postage stamp. This is especially true of the Palomar Mountain Observatory stamp, which, I believe, has received more advance notices on a national scale than any stamp issued during the thirty years I have been connected with the Post Office Department.

"It is fitting and proper that the first Observatory stamp should bear a likeness of this great structure, wherein is housed the mighty Hale telescope, the greatest instrument to search the heavens the world has ever known. It is proper too that the first sale of this stamp should be here at Palomar Mountain, where in the years to come the veil of a billion light years will be lifted, great problems solved, and important questions answered, which in turn will raise even greater problems and other questions.

"From time immemorial man's progress on earth has been measured by his

ability to seek out the truth, to overcome the obstacles of fear and doubt, and thereby benefit from the lessons which truth teaches. It is only naural that man in his quest for truth should lift his eyes to the heavens, and there in the boundaries limited only by his vision and ability to think, find answers to his doubts and fears and courage to go forward in even greater search for truth.

"The Ptolemys, Galileos, Newtons, and Hales, and the countless others who devoted their adventurous lives to a better understanding of the Universe and the natural laws—to seeking out the truth—have reserved for themselves a place in history and a special niche in what could be called 'The Hall of Men Who Sought After Truth.'

"What good is astronomy and why should it be commemorated? We could probably live without astronomical researches—the pursuit of knowledge for its own sake, without hope or thought of practical gain. But it is these very things that men do, that they do not have to do, that set them above and apart from the beasts of the field and, indeed, but little lower than the angels.

"Certainly, to primitive man, the recurring display of a star-studded sky must have been a baffling, yet inspiring sight. We can imagine him as he stood before his cave lifting his eyes to the spangled skies. Could he help but gain in spiritual stature? Could we not assume that because he raised his eyes to the stars he learned to walk upright—and changed from brute to man? 'Knowledge begins in wonder.' 'A man learns nothing if he hasn't learned to wonder; and astronomy better than any other science teaches him something of the mystery and grandeur of the Universe.'

"In the issuance of this new postage stamp fifty million opportunities will be presented for people to see a picture of the greatest observatory in all the world.

"May this stamp carry into every home and office in this broad land, and to the four corners of the world, the new knowledge that this great instrument will lay before the minds of men bringing them a little nearer to an understanding and appreciation of the mighty immensity of all creation."

Dr. Ira S. Bowen, Director of Mt. Wilson and Palomar Observatories, contributed to the ceremonies as follows:

"The Palomar Observatory from its inception has been a cooperative enterprise. The inspiration for the project came from Dr. George E. Hale, at the time honorary director of the Mount Wilson Observatory. The funds for the construction of the Palomar Observatory and its equipment were given by three of the Rockefeller boards to the California Institute of Technology, which is the legal owner of the Observatory. During the design and construction of the Observatory there has been the closest cooperation between the astronomers of the Mount Wilson Observatory, which is a department of the Carnegie Institution of Washington, and the engineers and physicists of the California Institute. But this cooperative effort was not limited to the staffs of these two institutions. Many firms like Corning Glass, General Electric, Westinghouse, Consolidated Steel, and Ford Instrument contributed the best of their engineering skills to the design and construction of various parts. Outstanding scientists and engineers from a large number of universities served as consultants.

"Finally, when extensive measurements showed the superiority of this mountain as a site for the Observatory, San Diego County, through its supervisors, rallied to the support of the project and provided the fine road up which most of us have driven today. Without this very substantial assistance from the County,

it probably would not have been possible to place the telescope in the ideal location that it now has.

"Furthermore, as the construction phase of this project is drawing to a close, we have every reason to believe that this type of cooperation will continue in the operation of the telescope. Already the trustees of the California Institute and of the Carnegie Institution have formally approved an agreement for the joint operation of the Palomar Observatory and the older Mount Wilson Observatory. The two observatories will have a common staff and the equipment of both observatories will be available to all members as needed for their investigations.

"But the use of the telescopes of these two observatories will not be limited to local astronomers. Plans are already in operation for the invitation of outstanding astronomers from all over the world to come to the observatories and make use of these facilities as guest investigators. During the past year, astronomers from Princeton, Harvard, the Smithsonian Institution, and the Universities of Wisconsin, Indiana, Lund in Sweden, and Louvain in Belgium have visited the Mount Wilson Observatory as guest investigators. With the addition of the facilities on this mountain, it is anticipated that the numbers of visiting guest investigators will substantially increase.

"High tribute has just been paid to this Observatory by the issuance of a commemorative stamp. In token of this, I have just received from Mr. Young an album of the stamps. This I wish to accept in the name of all those who have contributed to this project and in the name of those who will continue to use the instrument above us for the extension of our knowledge of the universe."

Other persons who participated in the event were Dr. Lee A. DuBridge, president of California Institute of Technology, Mr. DeGraff Austin, chairman of the San Diego County Board of Supervisors, Mr. Clarence H. Dawson, president of the Palomar Philatelic Society, and The Reverend Mr. Charles Severns, pastor of the University Christian Church of San Diego, who gave the invocation.

Book Reviews

Observations of Planetary Surfaces

Two volumes bearing this title have recently been received from Observatoire Jarry-Deslogues, the one pertaining to the year 1924, the other, to the period from 1926 to 1941. The Moon, and the planets, Mercury, Mars, and Jupiter, were included in the observations. Numerous drawings of salient features of the several planets are included with extended descriptions of the observations. These volumes form an important addition to the voluminous literature relating to a study of the planets. These volumes are, of course, in the French language.

Astronomie. Les Astres; L'Univers, by L. Rudaux and G. de Vaucouleurs. (Librairie Larousse, Paris-VI.)

The above is the title of a recently issued large-sized volume of nearly 500 pages, profusely illustrated, somewhat similar to the "Splendour of the Heavens" which was issued in two volumes in England in 1925. The present work was begun by L. Rudaux, director of the Observatory of Donville, and finished after his death by G. de Vaucouleurs, a member of the research staff of the Paris Astrophysical Institute. It contains a foreword by A. Danjon, the director of

the Paris Observatory. The following comments concerning it are translated from a French review of it.

Notwithstanding the great progress which science has made in the domain of observational astronomy, the public in general and, indeed, many educated persons have ideas of this marvelous sector of human knowledge only slightly different from those held by our ancestors. In this large work one will find the essential answers to the questions which, although very compelling, at first sight seem to have little to do with every day life. Of the three parts, the first two are devoted to a study of the solar system, and the third to a treatise on the stars. Nearly one thousand very good photographs illustrate this work, to aid the text and to make it live in the imagination.

Every cultivated person should have this volume at hand and should consult it often. He will read it like a romance, for it is a sort of a romance of the sky, a history of the universe. —C.H.G.

Rinehart Mathematical Tables, compiled by Harold D. Larsen. (Rinehart and Company, Inc., New York.)

This recently issued volume of mathematical tables will doubtless be found to be of much use to many students and others. It is difficult to think of any tables which are not included in it. Part one contains no less than 27 different numerical tables, including, in addition to the usual logarithmic tables and tables of trigonometric functions, such unusual ones as common logarithms of factorials, ordinates and areas of normal probability curve, and others. Part two consists of fifteen lists of data of various kinds, ranging from the Greek Alphabet through Hyberbolic Functions to Definite Integrals and Series. A feature not always found in such volumes is a section of Curves for Reference. This collection of curves, which is quite complete, including eighty or more, is arranged in alphabetical order and includes all the standard curves met in elementary mathematics.

It is a standard sized volume of 160 pages, neatly and sturdily bound, and evidently made to give service for a long time. —C.H.G.

Chart of the Isotopes

A chart of isotopes, revised to April, 1948, has been prepared by Dr. G. Friedlander and Dr. M. L. Perlman of the General Electric Research Laboratory. An isotope chart or N-Z diagram is not new, at least two forms having been previously published. The first was J. Mattauch's pioneer N-Z diagram.[1] His complicated symbolism for nuclear reactions and radioactive decay seriously limited the usefulness of the chart. Dr. Emilio Segrè recently developed an improved N-Z diagram.[2] He uses no symbolism for reactions or decay, which may be considered an over-simplification. He includes a profuse amount of data in each square designated to an isotope, some of which may be unnecessary for a chart of this type.

The Drs. Friedlander and Perlman seem to have struck upon a happy medium between these two extremes. They have made it an easy matter to distinguish at a glance between natural stable isotopes, natural radioactive isotopes, and the artificial radioactive isotopes by means of shaded, black, and white squares, respectively. They have not, however, developed a simple symbolism whereby they might indicate known nuclear reactions on the chart.

The approximately 750 isotopes, known at the time of revision, are plotted in three oblique columns with Z, the atomic number, as the vertical axis and N, the number of neutrons per nucleus, as the horizontal axis. This reversal of customary axes merely serves to provide a simpler layout of the chart. The data listed in the isotope squares include the symbol, mass number, abundance, and isotopic mass in the case of the stable isotopes. Listed for the radioactive isotopes are the classification, symbol, mass number, half life, mode of decay, radiations and their energies. Isomeric states are also neatly represented. Accompanying the chart is an elementary booklet on isotopes written by James Stokley, also of the General Electric Research Laboratory. It provides useful information for those unfamiliar with the rudiments of this science.

[1] J. Mattauch and S. Fluegge, *Nuclear Physics Tables,* Interscience Publishers, Inc., 1946.

[2] *The Science and Engineering of Nuclear Power,* edited by Clark Goodman, Addison-Wesley Press, Inc., 1947.

DONALD STORK.

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Astronomy, a Textbook for Colleges, by William Lee Kennon. (Ginn and Company, Boston 17, Massachusetts. $5.50.)

A copy of this new textbook has recently been received at the office of *Popular Astronomy.* The format is slightly larger than the average text and the volume contains 737 pages. The discussion is divided into four parts with a total of 31 chapters. A list of the titles of the chapters would show, as is, of course, necessary, that the customary topics are presented. The reader is impressed with the large number of well printed diagrams and photographs, ranging in time from Tycho Brahe's "Uraniburg" to the quite modern Adler Planetarium in Chicago.

The author of the volume expresses, in his preface, the conviction that a proper understanding and appreciation of astronomy require a background knowledge of the other natural sciences. In keeping with this premise he has included in the appendix certain tables and other pertinent material which is not astronomical in a narrow sense.

Considering its size, its comprehensiveness, and its recency, this volume is to be recommended not only as a college text but also as a reference work and, as such, worthy of a place upon the shelves of all libraries which furnish cultural as well as scientific material for their patrons. —C.H.G.

Geology Applied to Selenology III. Lunar Catastrophic History, by J. E. Spurr. (Printed for the Author by the Rumford Press, 1948. 245 pages plus index; 46 text figures and one plate. $5.00.)

This is the third of Professor Spurr's books on the moon, and no one should attempt to read it without having the first two at his very elbow, together with a map of the moon. I doubt that a page can be found in Volume III that doesn't refer to essential matters in I or II; and both earlier books are incomplete without the present volume, for here the author puts all his facts into an orderly history with which he combines the time-divisions already recognized by other selenologists. His terms are his own, dividing the legible moon-record into three great eras—Proteroselene, Mesoselene, and Teleoselene. I have used the word "eras" for the sake of brevity; but the author is careful not to use it or any

other word that has served to designate a time division in geology—such as period, epoch, age.

The Proteroselene is divided into Early, Middle, and Late periods. In Early Proteroselenic time the "primordial" surface was relatively firm or plastic and was characterized by numberless craterlets. During this time rotation virtually ceased and the earthward bulge accompanied the development of moon-wide fractures. Then a general minor ebullition began in the softened crust, and silicification took place on a vast scale along the polar grid system of fractures, in the "meridional ridges of appression" and around the walls of earlier craters. The resulting skeleton of indurated crater-and-fault structures has been called the Primitive Complex, including the Taurus Formation.

Middle Proteroselenic time saw wide-spread crustal deformation "produced by shrinkage and appression" after the Primitive Complex was formed. Presumably a great time-interval elapsed between the two eras; and a new set of fissures of the polar grid system was formed in the south polar and eastern regions. These fissures were filled with "a tought resistent material, not regarded as siliceous," represented now by knife-edged fault-septa.

In Late Proteroselenic time the large grabencraters developed, and the large and small sinks, many of which cut through the more ancient Taurus complex.

The Early Mesoselene continued the selective re-melting which began in the Early Proteroselene. Appression continued at a lessened rate. Grabencraters of Ptolemæus and Clavius age and type developed. Great domes began to form, of which the Imbrian was the largest; and early Imbrian faulting began.

The Middle Mesoselene contains the Imbrian revolution, with increased melting, collapse of the Imbrian and lesser domes, collapse of the uplifts which made great grabencraters and caldera-craters. The Frigoris and other late Imbrian faults were formed.

The Late Mesoselene continued the record of re-melting and warping. In the south central region many craters of the Stöfler type developed, and caldera-craters between the Mares Imbrium and Frigoris.

The Teleoselene brought the moon to its present aspect; but large events were still to pass. During the early part the older mare surfaces froze, the southern mare basins were deepened, flooding by novabase lava was renewed, and wrinkle-ridges were formed in the stiff lavas.

In Middle Teleoselene all these activities were continued and fields and streaks of ash extended about many craters including Tycho, Copernicus, Kepler.

Late Teleoselene witnessed the freezing of the novabase crust and the formation of the latest supra-mare craters, followed by "general contraction of the crust and opening of fissures in both lunarite and lunabase."

The author has shown a clear appreciation of the length and complexity of the moon's history; and even if not all students will agree with all his inferences, they will be grateful for his insistence upon a long, complex history. The names too, are fortunately chosen. You may ask: "Why not Archæoselene?" But that would suggest a beginning, and we may be sure that the oldest visible features of the moon are replacements of earlier features long since obliterated. The author's rejection of the name "Primordial Complex" is wise for the same reason—it is a complex in the geological sense, but far from primordial. And why not Cenoselene? Because this would connote recent events; and the author holds that the latest events recorded on the moon preceded the beginning of the earth's geological record.

This latter inference is in accord with G. K. Gilbert's claim that the earth

and moon must have developed similar mares, craters, and fault-blocks during their primordial era when both planets were spending the superheat they brought from the sun. But the earth, having sea and air, obliterated its early moon-like face and replaced it with folded and complex mountain structures for which the moon has no analogue; while the moon retained forever its record of a truly primordial type of topography.

I cannot follow these arguments, and wish that the author had not dated the moon's history earlier than the Archæozoic. If I were writing a paper instead of a review, I could submit an alternative thesis for the same facts, extending the moon's catastrophic history well into the earth's geologic record.

The volume is divided into three major parts. Part One, of seven chapters, is titled: "Special Studies in Crater Growth and Structure." The author traces a continuous evolution from obscure "ghost-rings," through mature crater rings to "dishcraters," then to caldera-craters and finally to grabencraters and graben—the latter two types are found only in the lunarite areas, where the crust was thickest. Many typical craters of all classes are studied individually, and a history of each is deduced from the visible structures. Studies of re-melting and of ash-fields lead to the inference that water vapor and other gases formed gas caps or "atmodomes," from which torrential rains fell and carved valleys before the gas cap dissipated. Part One also includes two chapters on the Mare Imbrium, which work out a time sequence for the events in that most instructive region.

Part Two, of six chapters, is devoted to "The Earlier Proteroselene" and considers all areas that can be assigned to the most ancient readable period of moon history. The study of fault-blocks and fracture-systems occupies many pages. A typical example is the Taurus Formation—often called "The Primitive Complex." It consists essentially of closely packed craters, forming a mosaic pattern of subangular ridges, plus a system of moon-wide fractures, plus the effects of differential melting. The whole complex has been arched up to form a dome of rugged country whose margins dip down to the mares, where increased melting has destroyed the Taurus structures.

Part Three, called "Problems of Lunar Diastrophism," includes three major divisions, each with its own title and chapter system. A helpful "distinction of forces" opens the discussion. The term "diastrophism" designates all processes that have altered the moon's face. Under this term, general forces are called "enselenic," *e.g.*, the east-west appression force. Forces in which we trace the effects of the earth's gravity are "telluroselenic." Forces due to movement of magmas and their contained gases are "vulcoselenic." The several groups of forces interact with one another; for example, telluroselenic forces caused the moon's rotation to cease; and as this lessened the centrifugal force due to rotation it led to increased enselenic appression, hence to increased melting and vulcoselenic action. The melting began in Proteroselene time, and culminated in the Imbrian revolution during the Mesoselene.

Four chapters are included under the first subdivision of Part Three called "Enselenic and Related Phenomena." The monstrous abundance of lunar gases is proved by the vast number of craters of all sizes and by the inflation-domes or "bubbles." Many craters show deformation by appression and by mutual interference.

The second subdivision of six chapters is titled "Telluroselenic Movements." The polar grid fractures are obliterated throughout large areas by later diastrophism, but enough are discernable to reproduce the pattern; and this reconstruc-

tion forms the frontispiece of the book. The author estimates that the equatorial circumference has shrunk approximately ten per cent of six hundred miles—a radial shinkage of about one hundred miles since Late Proteroselene. These figures appear to me to be too large. Indeed, throughout the book I am disturbed by inferences based upon the concept of larger shrinkage than I can consider probable. Many of the structures, such as crimp-faulting, need not be caused by true crustal shortening, but only by overthrusting, which, on the earth, does not imply crustal shortening.

This section also includes a study of the catastrophies of the Middle Teleoselene—great floods of novabase lava, crustal collapses, ash explosions, warping. The moon's face records two catastrophic climaxes—the first, in Middle Mesoselene, was the collapse of the Imbrian inflation and related movements; the second, the Middle Teleoselene events just mentioned.

The book closes with a critical summary of the moon's recorded history. This is not a repetition of the lunar time divisions at the beginning of Part One; but though a review lacks space for two summaries, I must touch one point. The author opens the summary with the capture of the moon by the earth; and defines capture as the arrest of the moon's rotation by the earth's tidal pull. This definition is valid whether you hold that the moon was born out of the earth, or that the moon was an independent planet, now playing Ham to its master-brother, the earth. Professor Spurr seems to favor the latter theory, though as a scientist, he confines his statements to fact and inference from fact.

And last, a word to the reader. If you tend to forget what you read, or if you don't carry visual pictures in your mind, don't buy this book. It is not light reading, but it is astonishingly rich in facts and ingenious interpretations of the facts. For the thoughtful reader who will buy a map of the moon—say, Elger's—and who will then read all three books, a full harvest is prepared. He will not only learn much and think more about our nearest neighbor-planet, but he will see with what extreme caution we may apply earth-concepts to the moon; for the moon has had its own history.

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Publications Received.—The publishers of POPULAR ASTRONOMY hereby acknowledge receipt of the following named publications and express their great appreciation of the courtesy shown on the part of those who have sent them.

Harvard Reprints:

No. 300. Variable Star Notes from the A.A.V.S.O.

No. 301. "Comment on the Wolf-Rayet Atmosphere," by Richard N. Thomas.

No. 302. "The Extinction of light of the Night Sky," by S. L. Piotrowski.

No. 303. "Some Remarks on the Determination of Intermediate Orbits of Eclipsing Variables," by S. L. Piotrowski.

No. 304. "Some Remarks on the Weights of Unknowns as determined by the Method of Differential Corrections," by S. L. Piotrowski.

No. 305. "Galactic and Extragalactic Studies, XVIII. The Pulse Index for Eighty-nine Variable Stars in the Magellanic Clouds," by Harlow Shapley.

One Hundred and Second Annual Report of the Director of The Astronomical Observatory of Harvard College.

No. 730. "Atomic Lines in the Spectrum of R Andromedae," by Paul W. Merrill.

No. 731. "Relative *gf*-Values for Lines of V_1," by Robert B. King.

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